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THE EXCAVATION OF THE WEST NEEBISH CHANNEL IN THE ST. MARY'S RIVER, MICHIGAN.

An important piece of work now being carried out to facilitate navigation on the Great Lakes is the improvement of the St. Mary's River by the construction of the West Neebish Channel at what are known as the West Neebish Rapids, 17 miles below Sault Ste. Marie, Michigan. These rapids, as their name implies, were situated in the river channel on the west side of Neebish Island, and in their natural state extended a distance of half a mile over an exceedingly shallow water-course, with a maximum depth of about 3 ft. and a width of a quarter of a mile. The rock dike of Niagara limestone forming this barrier between Neebish Island and the mainland, is about 2½ miles in width, from deep water to deep water. This dike, which constitutes the bed of the rapids, is one of the two low points in the ridge, whose higher parts form Sugar and Neebish islands. The other low point is the Middle Neebish Channel on the north side of Neebish Island, and between it and the southern extremity of Sugar Island. This is the channel now used by all the traffic between Lake Superior and the other great lakes. It was excavated for the U. S. Government by contract, by the method of submarine blasting and dredging, and required five years to complete.

The work on the new West Neebish Channel was commenced in May, 1904, and is expected to be completed by December, 1907. It includes two different methods of construction: (1) Excavation under water; (2) excavation in the dry, the original channel having been closed by cofferdams and then pumped out. A sketch of this channel is shown in Fig. 1. The contract requires the excavation of a clear channel width of 300 ft. from Station—30 on Course 5 to Station on 1,180 on Course 6, a distance of 13,300 ft. Of this distance, 8,560 ft. is called rock excavation, in which there are 1,700,000 cu. yds. to be removed; and the balance is 287,000 cu. yds. of earth. There is considerable stripping of earth and boulders (river drift) in the rock section, and a good deal of rock projecting above the 22-ft. plane in the earth section. In the dry section this stripping has run from scraping to 15 ft. in some places, and the earth is estimated at 12% of the rock excavation. The depth of the rock varies from nothing at either end to 27 ft. near the middle.

VIEW OF WORK ON THE WEST NEEBISH CHANNEL.
(The steam shovel is shown working on the first or upper lift; behind it the second lift has been taken out.)

COMPLETED PORTION OF 300-FT. CHANNEL, SHOWING THE DRY STONE WALLS LINING THE SIDES ABOVE THE SURFACE OF THE ROCK.

EXCAVATION UNDER WATER.

This part of the work covers the end portions of the channel beyond the dams of the central portion. It also includes the removal of these dams and the natural bed of the river underlying them, at the conclusion of the excavation in the dry. This work is being done by the dredge "Majestic," which was described in our issue of Feb. 7, 1907, and which has done some notable work in excavating solid ledge rock without blasting. This dredge has been excavating the channel and the triangle at the intersection of Courses 5 and 6, above the upper dam (Fig. 1). The ma-

terial encountered consists of river drift, similar to that on the Chicago main drainage canal, near Lockport, known there as "glacial drift." This might be expected to be more easily worked, from the fact of its being submerged. As a matter of fact, it is very hard digging, because of its cemented character and the number and varying sizes of the boulders that go to make up a very large proportion of the mass. Underlying little loose material found in the channel. At the upper dam, the top consisted of material from a conveniently located borrow-pit, transported by scows and unloaded by clam-shell bucket and by hand at the site. A small quantity that had been dredged from the river bottom was also unloaded from dump-scows by the clam-shell bucket. This dam was completed by Nov. 1, 1904.

which was remarkably small in amount first, has grown less each year, till at present there is scarcely any seepage.

In order that the current might be checked, so that the main dams might be built in still water, as a matter of economy, what was known as the temporary dam was built across the channel near the crest of the rapids. This is shown at C, on the map. This effectually closed the chan-

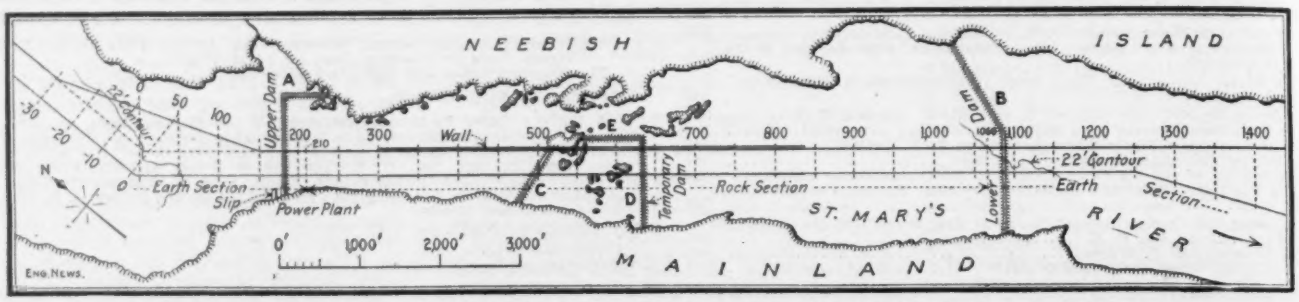

FIG. 3. SKETCH MAP OF THE NEW WEST NEEBISH CHANNEL IN THE ST. MARY'S RIVER, MICHIGAN.

this is the limestone bedrock. Into this the dredge has worked, bringing up pieces that show that ledges 42 ins. thick have been encountered and removed, without blasting.

EXCAVATION IN THE DRY.

The essential features of the work on the main or central portion of the channel are the two earth dams, the use of steam shovels on traction wheels, the distribution of warm feed-water, and the use of cableways (operated by compressed air) to handle the excavated material. The dams are in fact cofferdams, cutting off the flow of water through the West Neebish Channel, and forcing it to find an outlet through the Middle Channel. The upper dam is 1,900 ft. long, and the lower one 2,600 ft. They are situated 8,940 ft. apart. The included area of the river channel was then pumped out, enabling the cableway towers to be built, and the operation of excavation to be prosecuted in the dry.

DAMS.—In the construction of the dams, there were two distinct operations: (1) The base was deposited in place by unloading dump-scows along each side of the dam, until the depth of water became too shallow for this purpose; (2) the top was put on by other means. After depositing material along the axis of the dam, with scows, this base was then widened out by the same methods, until the top was of sufficient width to carry the remaining height of the dam.

In the case of the lower dam, only the base was completed by the close of navigation in 1904, and the work was carried on through the ice by special methods, as shown in Fig. 2. After the ice had formed to a sufficient thickness to support the operations, two channels were cut in it, parallel to the axis of the dam, and in such a location that material hauled from a borrow-pit of gravelly sand on shore, and dumped from sleds through these channels, would form a supplementary embankment on each of the shoulders of the base, to a height reaching

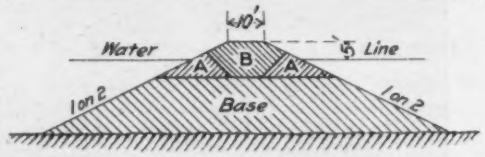

Fig. 4. Method of Building Earth Dam Across the West Neebish Channel.

the surface of the water. This is shown at A, A, in Fig. 2. Next a movable trap was built, transversely to the axis of the dam, with inclined approaches, and of a height sufficient to form an embankment, B, about 4 ft. above the ice. Material was then dumped from this trap, forming the crest above the water level, after which the top was widened and finished to a height of 5

nel, and diverted the water to the Middle Channel. A secondary temporary dam, D, at right angles to the channel, was built part way across, 1,500 ft. further down stream. These two dams were then connected by a third, E, parallel to the channel and far enough away from it to permit of the construction and erection of the cableways, after this enclosed area was pumped out. This plan enabled the contractors to commence the operation of excavation two months before the completion of the upper dam, A, and ten months before the completion of the lower dam, B. Thus it was possible to inaugurate the work of rock excavation four months after the contractors entered upon the ground.

EXCAVATING AND HANDLING MATERIAL.

During the construction of the temporary dams, an air-compressing plant of 1,000 HP. was installed for operating the channelers, drills and cableways. This plant is located near a slip and a coal dock built at the upper dam. It consists of two units: one being a 700-HP. Newburgh-Corliss engine, and the other a 300-HP. Hamilton-Corliss engine. Both are of the cross-compound type, and each is connected to a Rand two-stage air-compressor. Steam is generated by three 250-HP. Erie City water-tube boilers. The air pressure is maintained at 90 lbs. at the compressor, but varies from 80 to 90 lbs. at the cylinders of the cableway engines.

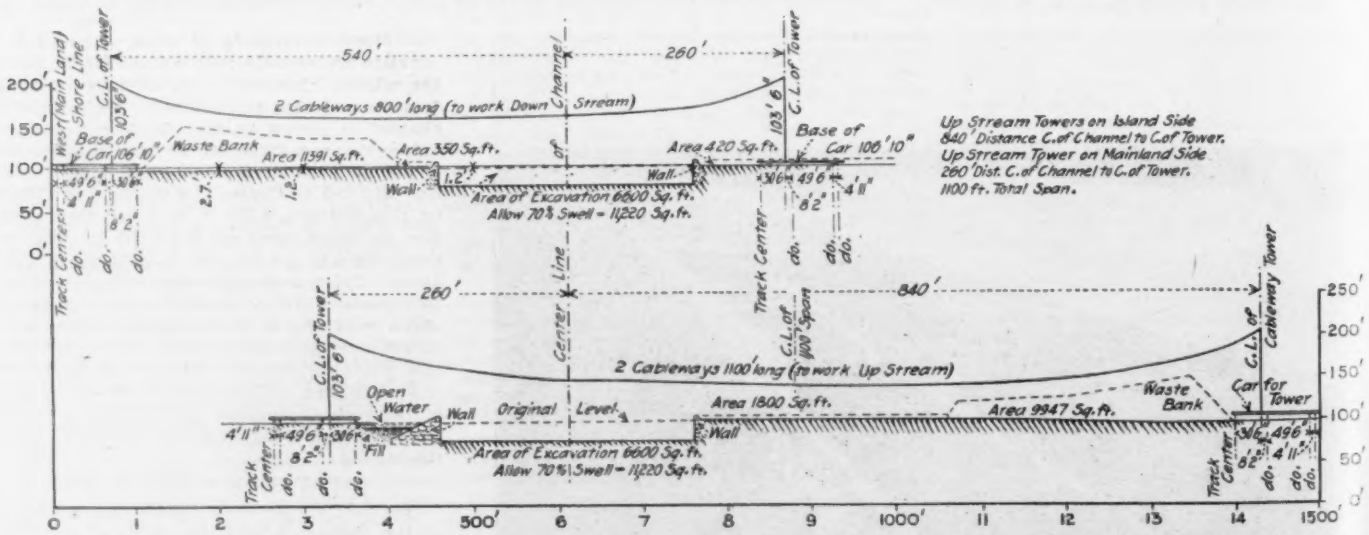
West (Main Land) Shore Line
C.L. of Tower
540'
260'
2 Cableways 800' long (to work Down Stream)
Base of Car 106'10"
Waste Bank
Area 1139 Sq. Ft.
Area 350 Sq. Ft.
Area 420 Sq. Ft.
Wall
Area of Excavation 6600 Sq. Ft.
Allow 70% Swell = 11220 Sq. Ft.
Track Center
Center Line of Channel
Up Stream Towers on Island Side
840' Distance C. of Channel to C of Tower.
Up Stream Tower on Mainland Side
260' Dist. C. of Channel to C. of Tower.
1100 ft. Total Span.
840'
2 Cableways 1100' long (to work Up Stream)
Open Water
Original Level
Area 1800 Sq. Ft.
Area 9947 Sq. Ft.
Waste Bank
Car for Tower
Fill
Cableway Tower

FIG. 5. CROSS-SECTIONS OF THE WEST NEEBISH CHANNEL, SHOWING ARRANGEMENT OF THE TWO SETS OF CABLEWAYS.

The crest is 10 ft. wide, 5 ft. above the surface of the water, and the slopes are about 1 on 2. The material thus handled by the dredges and dump-scows was excavated preferably within the area of the new channel. Owing, however, to the proximity of the bedrock to the surface of the bottom in that portion of the river deep enough for dredging operations, there was very

ft. by side-dump cars. The river side of each dam, from about 2 ft. below the surface of the water to the crest, was riprapped with stone to prevent erosion from wave action.

It will be seen that these dams are simply earth embankments, with a crest 10 ft. wide and about 5 ft. above the water surface. It is interesting to note that the seepage through them,

The rock is broken up by channeling and blasting, and then excavated by steam shovels, which load the material into skips. These skips are handled by cableways and the material is deposited to form waste banks on either side of the channel. There are four Lidgerwood cableways, working in opposite directions. The cross-section of the channel and the arrangement of

the cableways are shown in Fig. 3, and it will be seen that each cableway deposits its material on only one side of the channel. The two cableways moving up stream, each working against a face of about half of the depth of the excavation, are of 1,100 ft. span, while the two down-stream cableways are each of 800 ft. span. This difference is caused by the requirement that a berm

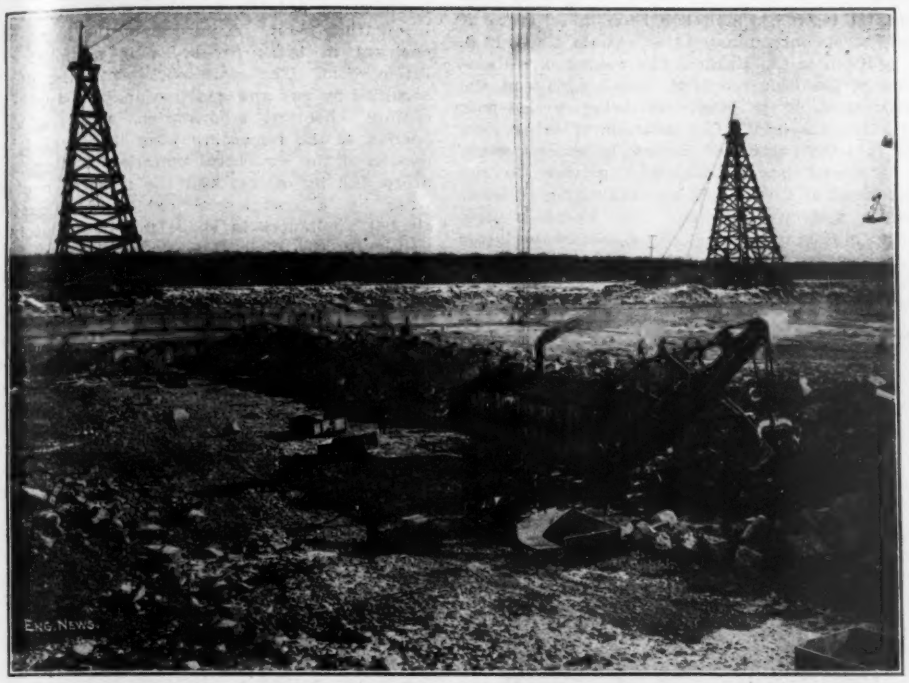

FIG. 6. STEAM SHOVEL HANDLING ROCK ON THE SECOND LIFT OF THE WEST NEEBISH CHANNEL.

of 300 ft. should be left on the east side of the channel. The waste, from local causes, had to be deposited east of this. The two shorter cableways, working southward, deposit the material on the west side of the channel, leaving a berm of 50 ft. Fig. 4 is a view looking down stream, showing part of the completed channel with a steam shovel working at the first cut or lift. Over this are the two cableways building the west waste bank, while in the foreground is a tower of one of the longer cableways.

Along each side of the channel, for the distance of about a mile, is a dry rubble wall, laid up with stone of cyclopean dimensions taken from the excavation. This is shown in the cross-section, and also by the view of the completed work, Fig. 5. The wall has a top width of 5 ft. It will rise 6 ft. above extreme low water, as an aid to navigation, thus making practically a perpendicular wall 28 ft. high, from its top to the plane of excavation. The sides have been channeled in two cuts, with but one offset of 9 ins. Thus the whole width of the excavation, 300 ft., will be available for navigation by vessels of maximum draft.

The special features of interest in the cableways are: (1) The use of the Trenton locked-wire main cable; (2) the permanent platforms attached to the carriages for their care and repair; (3) the steel reinforcement of the endless-rope drums on the hoisting engines, and (4) the operation by compressed air. It is explained that ordinarily the service of the cable is measured by the life of any of the outside locked wire strands, for if one parts and is forced out of place, the remaining strands become loosened. The whole outside covering which forms the wearing surface then becomes ineffective. On this work a system of brazing has been perfected, whereby a broken strand may be repaired in 1½ hours, and (it is claimed) be in better condition for service than it was before.

Under each cableway is a 65-ton Marion steam shovel with a 2½-yd. dipper, loading the material into iron skips 10 × 10 ft. and 2 ft. deep. The loaded skips are lifted by the hoisting cables of the engines in the headtowers of the cableways, hauled out, and dumped onto the wastebanks on the respective sides of the channel. Fig. 6 shows one of the steam shovels working on the second or lower lift. An important departure from the usual method of operating steam shovels consists in mounting these machines on traction gear. This has been done before with shovels of small dimensions, but is a decided innovation for the 65-ton machines, and is only practicable for such heavy machines when operating on a rock or other hard bottom, as in this case. With some improvements, principally in strengthening a few weaknesses developed by the exceedingly heavy continuous duty, these machines are said to have proved a great success. This running gear, on the comparatively smooth floor of the rock excavation, enables the steam shovel to turn around, move half way across the channel to a new working face, and commence work again in from 15 to 18 minutes. Fig. 7 shows one of

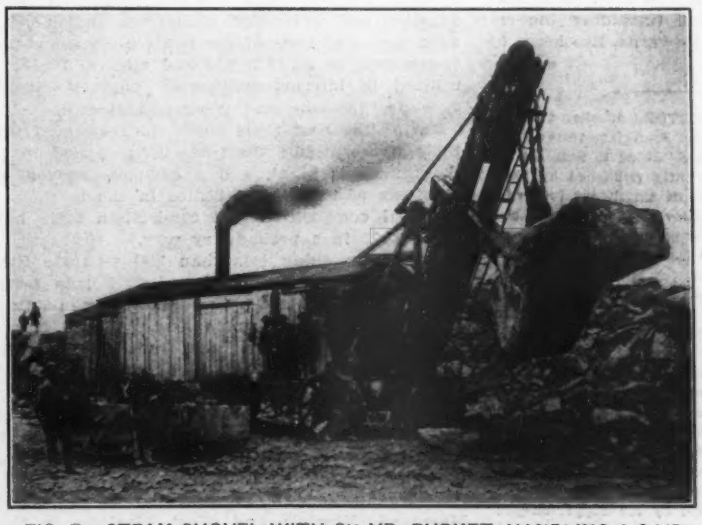

FIG. 7. STEAM SHOVEL WITH 2½-YD. BUCKET HANDLING A 3-YD. BLOCK OF STONE.
(The machine has traction wheels to run on the rock floor of the excavation.)

those machines (operated by Grant, Smith & Co., of Thorice, Mich.), handling a block of stone of 3 cu. yds. The longest dimension of the block was 8 ft. 3 ins., width 4 ft. 3 ins., thickness, 2 ft. It was loaded in 15 seconds.

There are four 8-in. channelers used, two Sullivan and two Ingersoll. Fig. 8 shows one of the Ingersoll machines, fitted with air reheater. The drilling is done by an average of eight Rand drills to a face, and from 10 to 15 tons of dynamite are used per month. In the blasting operations, the holes are drilled in two rows, 5 ft. from the face and 5 ft. apart. The holes are also 5 ft. apart and staggered. The firing is accomplished by a Bain electric battery, operated by a vertical air-driven engine. The capacity of this exploding apparatus is 500 holes, but the maximum number fired on this work has been 130. The rock breaks up well, although it is harder than that encountered on the Chicago drainage canal. For this reason the expense for powder has been increased very materially. The shovels, however, have demonstrated their ability to handle any size of block up to 3 cu. yds., as already noted. The average skip load is 2.7 cu. yds., and the number of skips, averaged on the basis of a 10-hour day, is 155 for the record month.

The method of procedure is to drill and blast a face of half the width of the channel. While the shovel is taking out this loose material (beginning at the middle), the remaining face is being drilled. By the time one-half is cleaned up, and the shovel is at the opposite side of the channel, the face of the other half is shot. The shovel then turns around and proceeds to the center, where it begins to work towards the other side. The pumping of this unwatered area is a comparatively small item, when it is remembered that it is a natural river bed. It is accomplished by a 12-in. centrifugal pump at each dam, working half time, except during spring thaws and very wet weather.

WARM FEED-WATER SUPPLY.—One of the special features of the methods of working is the system of supplying warm feed-water to each of the four shovels at all times, and especially during the freezing weather of the winter months. While the piping that conveys this water from the central feed-water plant is laid on the surface in the most direct lines, with no attempt at insulation, there has been no trouble from freezing. By this system, the shovels, although situated almost 1½ miles apart, have been supplied with feed-water in the most satisfactory manner. The water-heating plant consists of a 10-ft. tank into which water is diverted from the flume that carries off the drainage from the main sump. This water is then heated by diverting into it the exhaust from the 8-in. and 12-in. duplex pumps which are immediately in front of the house containing the heating plant. These two pumps are housed in close to the edge of the sump and a little above it. For the greater part of the time the smaller one alone is used, and is run at reduced speed. They are both connected with the air line, so that if desired, they may be driven by compressed air.

A 6 × 4 × 6-in. duplex feed-pump forces the water through a 2-in. pipe to the four shovels, and to the one channeler and four wall-derricks that are operated by steam. After a shovel has been supplied with water, a ½-in. air cock is opened, and all water remaining in the pipe is then blown out. As a certain amount of water will collect at low points (sufficient to close the pipe occasionally) a steam connection is also made with this supply pipe, so that in freezing weather, when ice forms in the pipe, it may be thawed out by turning in a jet of steam. By the alternate use of air and steam, the pipe has been kept open in the severest weather during the past three winters. As the primary object of this plant is to get the water to the shovels, the matter of its temperature was a secondary consideration. For this reason no attempt was made to attain a high feed-water temperature, the ob-

ject being solely to convey the water to the tanks on the shovels without freezing. At the machine it could be reheated with very little trouble if desired.

ENGINEERS AND CONTRACTORS.

The work above described is under the direction of Col. Charles E. L. B. Davis, M. Am. Soc. C. E., U. S. Engineers. Mr. L. C. Sabin, M. Am. Soc. C. E., is Assistant Engineer in charge of this district, and Mr. L. P. Morrison and Mr. Sutton Van Pelt, Assoc. M. Am. Soc. C. E., are Junior Engineers. The work is being carried out by contract by the McArthur Brothers Co., of Chicago, and for particulars and drawings of the work on the central portion, as described above, we are indebted to Mr. A. S. Robinson, the local manager of the company at Sault Ste. Marie, Mich. The subcontractors for this section are Grant, Smith & Co., of Thorice, Mich., and the progress and success of this part of the work is stated by Mr. Robinson to be due largely to the personal supervision of Mr. C. H. Locher, of that company, whose invention of the "aerial dump" made the cableway system so effective on the excavation of the Chicago drainage canal. Mr. Geo. P. Locher is superintendent for this firm. The subcontractors for the dredging (including the removal of the dams), are Edwards Brothers, of Sault Ste. Marie, Mich.

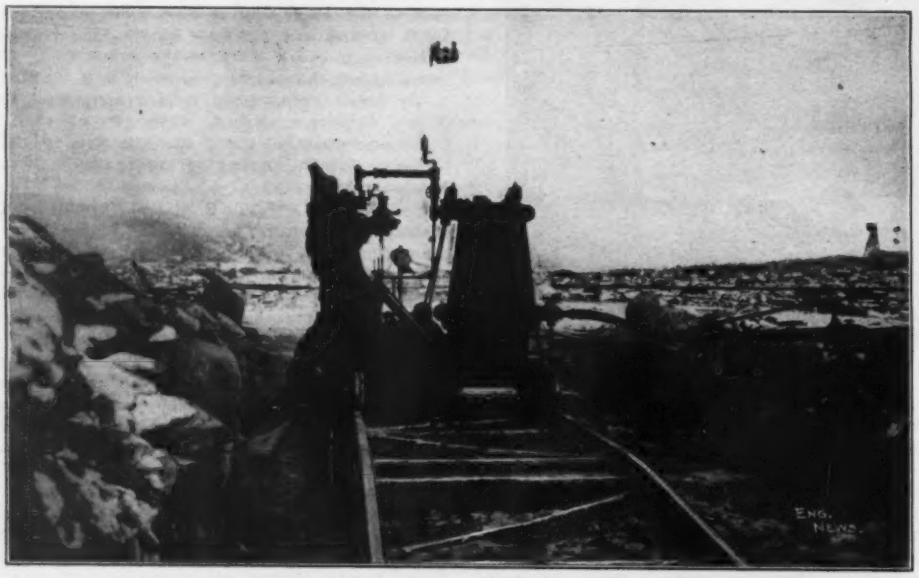

FIG. 8. INGERSOLL CHANNELING MACHINE WITH AIR REHEATER; WEST NEEBISH CHANNEL.

A MUNICIPAL GRAIN ELEVATOR, or silo, as it is there called, has been erected by Frankfort-on-the-Main and is described in the interesting "Guide to Some of the Public Works" of that city, recently published by Herr Koelle, City Engineer. A municipal warehouse for grain and other goods had been in use for some years, but had become inadequate when the new elevator was built "on the silo system" in 1900-1. The main building (there are offices in a small near-by structure) is 81 × 313 ft. in plan, 97 ft. high, and is divided by fireproof walls into four parts, three of which are for the storage of grain and the fourth is occupied by machinery. The grain is stored in 204 "cells," some of which are 51 and some 43 ft. in height. The storage capacity is 19,380 long tons. There is a feeding floor above and a bagging floor below. The foundation of the building consists of concrete 4 ft. 1 in. thick, reinforced with flat iron bars on edge. The piers supporting the cells are 3 ft. 10 ins. sq., are built of hard bricks and finished with granite blocks. These piers extend from the foundation to and through the bagging room, the roof of which is formed by the hopper-shaped bottoms of the cells. These bottoms are of reinforced concrete. The partitions between the cells are of wood, built up of planks. The planks, and therefore the thickness of the partitions, diminish from about 9 ins. at the base to 4 ins. at the top. These 2-in. planks are laid flat, bonded, and secured by nails about 5 ins. long. The wood surfaces forming the interior of the cells were treated with sulphate of alumina. Hoods, ducts and exhausters are used to remove dust from all places where it would occur. All the machinery is driven by single-phase alternating-current motors. With all the plant in operation at one time, about 200 HP. would be used. The plant can handle from some 80 to 100 long tons per hour. The total cost of the elevator was about $392,000.

THE FUEL-TESTING PLANT OF THE UNITED STATES GEOLOGICAL SURVEY AT NORFOLK, VA.

By HERBERT M. WILSON,* M. Am. Soc. C. E.

In April last the Secretary of the Interior organized a new branch of the United States Geological Survey known as the Technologic Branch. Into its charge has been put the work of fuel testing, which was commenced at the St. Louis Exposition in 1904, and the work of structural material testing, which has been in progress at the Forest Park plant at St. Louis since 1905. In addition to the straight fuel testing, investigations of the occurrence of fuels—chiefly on the public lands of the West—are being carried out; investigations into better methods of firing coal, and into the variety of furnace in which certain coals should be utilized, with a view to the abatement of smoke and best utilization of heat; records and investigations into waste of coal due to mining explosions; the causes of the latter and their possible prevention; the better use of explosives and the use of better explosives in coal mining; investigations into the mining engineering features of coal waste, due to bad methods of mining, handling and marketing the product; investigations into the occurrence, preparation and utilization of lignites and of peat as a fuel; and tests of the relative efficiency and commercial value of liquid and mineral fuels as utilized in internal-combustion engines—chiefly gasoline, kerosene and denatured alcohol.

During the past three years the testing of the fuels of the Middle West has been carried on at the St. Louis plant, and a complete survey of the fuels of the United States in the matter of chemical composition and combustion tests has been made in a preliminary way.

In all something less than 200 separate fuel deposits from Pennsylvania to California have been so tested. At the time of the organization of the Technologic Branch it was decided to remove the fuel testing plant from St. Louis to Norfolk, Va., with a view to making more extended tests on the fuels reaching tidewater for shipment to the naval and merchant marine of the world. These tests are planned especially with a view to indicating the general methods of utilization of the fuels from the New River, George's Creek and Pocahontas coal fields of Maryland, Virginia and West Virginia, in the hope of securing increased efficiency and of preventing waste and of thus extending the life of these coal deposits. This work has especially in view the needs of the Navy of the United States.

The Norfolk plant is located within the grounds of the Jamestown Exposition. This location was selected because of convenience in the way of transportation facilities furnished by the Tidewater Railway, now known as the Virginian Railway, and because the Exposition Company erected a building for the occupancy of the fuel testing plant, thus saving that expenditure to the Government. This building is situated to the right of the main entrance to the Exposition grounds, near the Service Building, and is admirably suited to the work. It is a one-story building, 325 ft. in length by 125 ft. in extreme width, and 44 ft. in clear maximum height. One end, 75 ft. in width, separated from the remainder by a brick fire-wall, is devoted to the briquetting plant. A portion of the same wing, enclosed in brick fire-walls, is occupied as a boiler room. The main part of the building is occupied by gas and gasoline engines, turbo-generators, chemical laboratories, offices, etc. A portion of the remaining wing is occupied by a section of the structural materials testing laboratory and by offices; and the remainder of this wing by a commercial exhibit of denatured alcohol appliances in space not immediately required by the Federal testing plant.

Tests of fuels are being made on long runs, on one type of fuel at a time, the tests extending over a sufficient period to permit of their approaching commercial conditions. For example, gas-producer tests made at the St. Louis laboratory were on runs of about 48 to 60 hours, and the maximum commercial conditions were only barely reached in the operation of the producers when the test would have to be discontinued. The results, while exceedingly valuable as indicating the relative efficiency of fuel in the gas producer or under the steam boiler, are being supplemented by the more prolonged tests being made at the Norfolk plant. Each type of fuel, such as that from a mine typical of a given coal seam, is tested in lots of about 150 to 250 tons. A portion is converted into producer-gas, and as the test progresses the best method of handling and firing to produce the maximum of high-grade gas is ascertained.

This plant consists of two Taylor pressure-gas producers; the inside lining of the brick jackets is 7 ft. high, and the height to the top of the casing 15 ft. The gas from the producer passes through a tar extractor and a scrubber, and then through a purifier into the gas holder. In operating this producer during several years on various types of soft coal, slack, lignite and peat, no difficulty has been found in working effectively, regardless of the amount of volatile matter distilled from the fuel. The gas holder has a capacity of 4,000 cu. ft. From it the gas passes through a meter and operates a Westinghouse gas engine of 235 HP. The power generated is converted into electrical energy by belting to a 200-KW. Bullock generator, and is measured on a switchboard from which the load can be regulated so as to maintain a steady full-load value.

Among the determinations made in this section are: The length of the test run; the effect of the size of coal; the maximum returns from different fuels; the response of the producer plant to sudden changes in demand for power; the effects of rapid load variations; the best depth of fuel bed, etc. In the course of the test, time is kept of the labor force, of the weight of all fuel, of ashes, of the fuel consumed in the auxiliary boiler, the amount and value of the water consumed, and every item which goes to make up the cost of producing 1 HP. from a given quantity of fuel.

Every shipment of fuel which is tested for producer gas is also tested for combustion in the steam section; and a portion of it is manufactured into briquettes, which are then tested in comparison with the run-of-mine coal from which they are manufactured, under the same boilers and by identical tests.

The steam section contains two Heine boilers of about 210 HP. each, and one Babcock & Wilcox marine type water-tube boiler of 250 HP. One of the three furnaces is equipped with a Roney overfeed stoker, one with a Jones underfeed stoker, and one for hand stoking only. The three may be operated on natural draft, forced draft, or through the Green Fuel Economizer Co.'s induced-draft fan. The baffling in the different furnaces is arranged differently, so as to procure different lengths of travel of the gases of combustion. It is thus possible to test

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the same fuel in different sizes, with different methods of stoking and draft, and to baffle in such a manner as to determine the most economical performance under different rates of combustion and the best arrangement of grate and heating surfaces.

The steam generated is used in operating two direct-current DeLaval Turbo-generator sets, each of which is rated at 300 HP. and is of a speed of about 9,000 r. p. m. The electricity generated, like that generated from the producer gas, is measured and controlled at the switchboard. The work of the steam section is so planned that the performance of the boiler is successfully isolated from the combined performance of the boiler and furnaces, and the tests are being continued with the object of determining still further the efficiency and performance of the furnace alone. The tests are also conducted with a view to determining the method of firing various fuels, so as to reduce to a minimum the smoke emitted from the stack. Both in the producers and in the boiler furnaces holes have been bored at various heights to permit of measuring the highest temperature in various portions of the combustion chambers and fuel beds, and for the extraction of samples of gas for analysis.

Included in the plant are a research chemical laboratory and a research physical laboratory, for conducting investigations into the gases of combustion. In addition to these research laboratories, there is a small commercial gas laboratory for analysis of the gas produced, and a small chemical laboratory for analyzing the fuels and ashes in the steam plant.

The fuels consumed at the plant are inspected at the mine before shipment, and samples are sent to the chemical laboratory for analysis. Similar samples are taken from the car-lots as unloaded, and from time to time as the fuel is fed to the producers and the boilers. By this means it is possible to secure, by chemical analysis, data which will permit of determining the values of fuels and their probable performance without test, by comparison with the behavior of those which have been tested and analyzed.

The briquetting room is equipped with a large American briquetting machine of the Renfrow type, and with an English briquetting machine of the Johnson type. The briquettes of the former weigh less than a pound each, are of flattened hemispherical section, and are about the size of furnace anthracite. The briquettes made on the English machine are rectangular, about 3 × 8 ins., and weigh several pounds apiece. Both briquetting machines are operated by a 50-HP. motor, the fuel being received from overhead bins on a mixing platform; there the coal and the binder (usually about 5 to 6% water-gas pitch) are mixed, and pass through a disintegrator; they are thence elevated into the tops of the briquetting machines, where they come in contact with live steam at a high degree of superheat. Thence the mixture passes into the briquetting machines, and is pressed into briquettes at pressures ranging from 1,000 to 2,000 lbs. per sq. in.

Experiments with various binding materials have been made, and are being continued in the experimental laboratory, located at the plant, in which both physical and chemical tests and analyses of briquettes are being conducted. At present the briquetting plant is occupied largely in the manufacture of briquettes from Pocahontas coal, for testing upon naval vessels. One hundred and fifty tons of Pocahontas coal have just been briquetted and delivered at the Navy Yard at Norfolk for testing on a battleship, in comparison with a similar amount of anthracite culm briquetted, and with anthracite run-of-mine and Pocahontas run-of-mine. Similar briquettes are to be furnished for testing under Norment water-tube boilers upon a torpedo vessel, and under Scotch boilers upon a naval tug.

It is believed that these fuels when briquetted will produce a little higher efficiency and develop somewhat more power in a given furnace than when not briquetted, and that they will burn practically without smoke. During the past few months extensive experiments on briquetted fuels, made at this plant, have been conducted in co-operation with the Pennsylvania R. R., the Missouri Pacific Ry., and other roads. The results of the tests made under the direction of Mr. A. W. Gibbs, General Superintendent of Motive Power of the Pennsylvania R. R., have been most gratifying in indications of the probable success to be attained in using briquetted coals, of even comparatively low grade, in producing with a given locomotive a higher efficiency than can be produced by run-of-mine coal; and also in the elimination of smoke by their use, under normal conditions of running.

In the liquid-fuel section, work of much importance is in progress in the determination of the relative availability and efficiency of gasoline, kerosene and alcohol. The equipment includes two 15-HP. Otto gasoline engines and two 15-HP. Nash gasoline engines; there are also a 2-HP. and a 15-HP. International Harvester Company's gasoline engine. Experiments are being conducted on the relative performances of gasoline and of kerosene, and of both as compared with alcohol. The experiments cover the whole range of this field, including the examination of the different carburetors with a view to determining the most efficient method of vaporization. As with the other tests, exact record is kept of the amount of each fuel used, the labor and water, etc., so as to determine the exact cost of producing a unit amount of power.

The fuel-testing plant is equipped with modern coal-handling apparatus. Hopper dumping cars are switched on to a track adjoining the plant, and the fuel is dumped into a pit, whence it is lifted 40 ft. by a link-belt elevator; from this it can be discharged either through a chute into the gas-producer bins, which are near by and on a level with the top of the producers, or into the bins of the boiler plant, or on to a Robins conveying belt which delivers the coal into one of two storage bins located under the roof of the briquetting plant.

Tests of lignites, both for producer gas and for briquetting, will be conducted in this plant, which possesses a large German lignite-briquetting machine. This lignite press has, however, not yet been installed, and it will doubtless be some time before funds will be available to permit its operation.

Tests of peat are being made in connection with a complete survey of the peat deposits of the Atlantic Coast. Several carloads of Dismal Swamp peat will be macerated in the disintegrator on the plant, dried and converted into producer gas.

In addition to the probable lines of tests in connection with the survey of the fuel deposits of the United States, which are being conducted at the Norfolk plant, the Technologic Branch of the Geological Survey has at Denver a plant equipped for tests of the availability of the western coals for coking purposes—especially those on government public lands. This plant is equipped with a washery provided with different types of jigs and with means for float and sink tests, etc.; the washed coal is thence conveyed to two standard beehive coke ovens. It is believed that the extended series of tests being conducted at this plant will result in improving the quality of the output of coke produced from western coals.

The Technologic Branch is under the immediate direction of J. A. Holmes, Expert in Charge, with the writer as Chief Engineer. The Norfolk plant is under the administrative charge of Mr. J. C. Roberts, Assistant to the Chief Engineer. The briquetting section is under the charge of Mr. C. T. Malcolmson; the gas producer section is under the supervision of Mr. Carl D. Smith, and the steam section of Mr. W. T. Ray; the gasoline and alcohol work are supervised by Mr. R. M. Strong. The work of these three sections is co-ordinated under Mr. D. T. Randall, Engineer of Tests, with Prof. Robert H. Fernald of the Case School of Applied Science, Cleveland, as Consulting Engineer for producer gas and gasoline tests; and Prof. L. P. Breckenridge of the University of Illinois, as Consulting Engineer for steam tests.

The results of the operations of the fuel-testing plant, up to the time of its removal from St. Louis last spring, are being prepared for publication in several progress and special reports which, it is expected, will be available for distribution within a month or two.

The Expert in Charge has arranged, with the coöperation of the Exposition Company, to have Oct. 25 designated as Fuel, Cement and Alcohol Day, and upon that date the various departments of the fuel and structural-materials testing plants will be in full operation in such a manner as to give the public an especially good opportunity for inspecting the work. This date has been selected because it is that upon which the National Advisory Board will hold its annual meeting; this Board was created by President Roosevelt to outline the series of tests to be made for the Government on fuels and on structural materials. Upon the same date the American Peat Association will be holding its first annual convention at the Exposition, so that altogether there will be much of interest at the fuel testing plant on that day to those engaged in the mining or utilization of fuels.

DISJOINTING CAST-IRON WATER MAINS.

The best means of taking up and again putting down old cast-iron pipe is a subject that always appeals to water-works superintendents. The topic was brought forward at the annual convention of the Central States Water-Works Association, held at Wheeling, W. Va., Sept. 17 to 19, 1907, and brought out a number of interesting points based on experience in various localities. The substance of this discussion is reproduced below, as being likely to interest many of our readers:

Mr. Latta, the author of the question, said that within the last two or three years he had replaced a large number of 6, 8 and 10-in. mains with 16 to 24-in. pipe. When he came to the works the method in vogue was to expose the old pipe, take a pair of cutters, cut off as close to the hub as possible and knock it out, losing from 6 to 8 ins. of cast iron pipe. This loss he reduced by cutting out every second joint and leaving the intervening joints intact.

Mr. Asa Williams, of Owensboro, Ky., stated that about five years ago he replaced 1,200 ft. of 8-in. pipe with 10-in., as follows: Three tripods were equipped with chain blocks. The pipe was cut at one street corner, at the valve, the pipe being in the ditch, and at the next corner at a fire hydrant T. The tripods were set about two lengths of pipe apart. The end of the pipe was pulled up, taking a strain with the other chain block, and when the end of the pipe got up to the top of the ditch a skid was placed across the top of the ditch to rest the pipe on. The tripod and chain blocks were then moved further down, continuing to place skids across the ditch until the entire length of pipe rested on the skids; it was then rolled off the skids and the other pipe placed in position. Every third joint of the removed pipe was then melted out; a wagon was gotten and a couple of 30-ft. telephone poles placed on it and two sections of pipe slung under the poles and the pipe hauled to the placed where it was to be laid. It is easier to melt the joints on top of the ground than in the ditch.

Mr. A. L. Holmes, of Grand Rapids, Mich., preferred to melt the joints out in the ditch, making the lengths as long as can be handled with teams, cutting the pipe far enough from the bell so as to put a sleeve on and handle it in that way. By using cutters, small pipe, say 4 and 6-in., may be got out of the way in a little while.

Mr. Williams stated that in melting joints in the ditch it is necessary to dig under the pipe and make a fire under it, and also that the time taken in cooling the ditch so that the workmen can relay the new pipe is a serious loss of time. It is a great deal cheaper to melt the lead out on the top of the ground. In reply to a question, Mr. Williams said that all he used to clean pipe was an ordinary flue brush. His pipe, although it had been in place 28 years, has required very little cleaning.

Mr. Latta referred to a sheet iron tank made in Cincinnati, to be filled with kerosene oil, having an air pump on the side by means of which a pressure of 30 lbs. or 40 lbs. could be had. This is fitted with burners. The objectionable feature of this was that the orifices through which the oil was burned easily became choked up, greatly impairing the efficiency of the burner. When it is working right one man can melt a joint in about 70 minutes.

Mr. W. A. Veach stated that about a year and a half ago he asked Mr. L. E. Chapin, of Canton, O., whether there was not some better method of unjointing pipe than by burning it out in the ditch; and was told that the Standard Oil people, in Cleveland, O., had an arrangement in the way of a jack that one of their men had designed that could be dropped down over the pipe, and had pawls in it that would prevent it from slipping, and that

they could push out 6 or 8-in. pipe out of the bell in a few moments; a very practical and very successful device. They relaid more or less cast-iron pipe every year, and they were very much pleased with it and used it entirely.

Mr. Scroggins, of Wheeling, inquired of Mr. Williams what kind of sediment in the pipe he was able to clean out with a flue brush. Mr. William stated that he had found some carbuncles, but had never struck anything that he could not push a flue broom through.

THE OTAVI RAILWAY IN SOUTH AFRICA: THE LONGEST 24-IN. GAGE RAILWAY IN THE WORLD.

The Otavi Railway, in German Southwest Africa, which has recently been completed, is notable for its light construction and for the fact that it is the longest 24-in. gage railway in the world, being about 300 miles in length. It was built for the Otavi Mines & Railway Co., a German concern owning copper mining properties at Otavi and Tsumeb, near the head of the line. The eastern end of the line parallels a portion of the military and colonization railway built some years ago by the German government and now extending from the port of Swakopmund to Windhoek. As shown by the map, Fig. 1, the Otavi Ry. extends in a direct northeast line from Swakopmund to Tsumeb, 360 miles. It is possible that this line may eventually be extended eastward to a connection with the general railway system of South Africa, but this is not likely to be done for very many years. The distances and difficulties are great, with little encouragement as to traffic, and as the line has been built specially for the transportation of ore westward to the coast, its further development eastward as a pioneer railway will undoubtedly be a very secondary consideration to the owners. In our issue of Sept. 28, 1899, we published an extended review of the railways of Africa. This showed that but little progress had been made with transcontinental projects, the development being mainly in a north and south direction and along the eastern side. The existing railway system extends through the southeast portion of the country (Eng. News, Nov. 26, 1903), reaching the east coast at numerous points. The great main line now extends several hundred miles north of the Zambesi River (which is crossed at the great Victoria Falls), or about 2,500 miles northward from Cape Town, but this has no westward branches, and no connection with the west coast.

To return to the Otavi Railway, this is an interesting line in itself, irrespective of its possible future relation to the railway system of Africa. The discovery of copper ore and other minerals in the Otavi district was made some years ago. After investigations had been made by several scientific expeditions, and the value and abundance of copper and other minerals had been proved, it was decided to connect this district with Swakopmund, the only available shipping port, by a narrow-gage railway. The construction work was started in August, 1903, and the line was completed towards the end of 1906. It was built by the firm of Arthur Koppel, of Berlin (and with American offices at Pittsburg and Chicago), this firm making a specialty of all material and equipment for light and portable railways. For photographs and for much of the information given below we are indebted to Mr. J. Hartley Knight,* who is interested in African affairs.

The contractors had to overcome a great many difficulties, of which the supply of water and labor were the most important. In January, 1904, the rising of the Hereros tribes against the colonists began in German Southwest Africa. The natives who were employed on the railway then decamped in large numbers, and as the remainder were recruited for military service by the government it seemed doubtful whether the work could be continued. The native labor had to be replaced and in May, 1904, an Italian contractor arrived with 300 Italian workmen. The construction was at once taken up again, but the contractor and his men had frequent disputes, with the result that he and a number of his men left the country. Those who stayed behind were engaged by the contractors.

In the meantime, the German State Railway to Windhoek (already mentioned) was unable to cope with the abnormally increased traffic due to military operations, and it was essential from a military point of view that the Otavi Railway should be completed to certain points with the utmost speed. The government therefore offered the contractors a premium if this part of the work was accomplished within a specified time. They consequently sent out 750 Italian workmen and engaged 500 Ovambo coolies. The work done by the Italians was very disappointing, as two of them would not do as much as one native. They were continually grumbling, and struck work on numerous occasions.

The conditions of the port of Swakopmund and the facilities for discharging the cargo from steamers proved absolutely unequal to the occasion, and in many cases it was several months before the material could be landed. The scarcity of water also delayed the construction to a great extent. At times the drinking water had to be taken on bullock carts over distances of 30 to 40 miles. Between Swakopmund and Usakos no water could be found, and it had to be brought up from Swakopmund, a distance of about 100 miles. It is considered very much to the credit of the contractors that in spite of all these difficulties, the line was completed in less than three years, at a rate of over 120 miles per year.

There are few heavy grades, and the steepest are 2%. The standard radius generally adopted for the curves is about 500 ft. (11½°), with the exception of ten places where a smaller radius has been necessary in order to avoid cutting through the rocks. The smallest radius is 262 ft. (22°). No special material was required for ballast, as the quartz sand found everywhere proved excellent for this purpose. Besides Swakopmund and the terminus at Tsumeb there are three stations: Usakos, Kilo 151 (about 95 miles); Omaruru, Kilo 233 (about 145 miles); and Otjivarongo, Kilo 378 (235 miles). There are also 42 sidings.

The total expenditure, including all the rolling stock, amounts to about $4,500,000. The cost of construction, including the grading, rails, ties, tracklaying, etc., is estimated at $12,000 per mile. During the past few months the freight as well as passenger traffic has increased to such an extent that the line is now self-supporting, and it is predicted that the company will be in a position to pay a dividend out of the profits made on the railway alone, in addition to the profits realized from the mines.

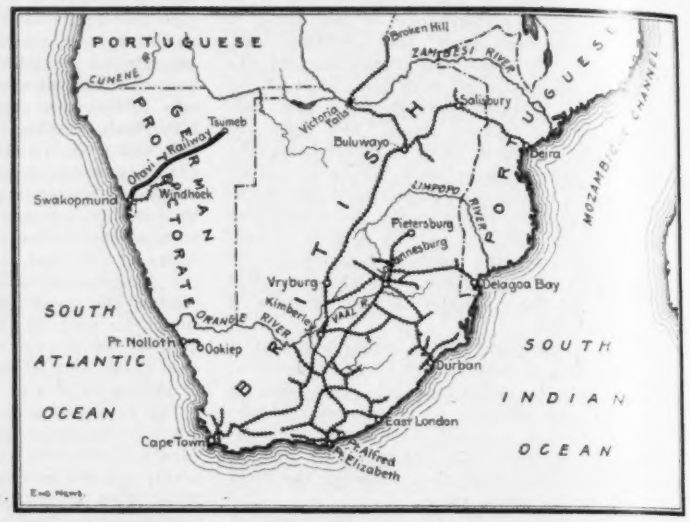

FIG. 1. MAP OF THE OTAVI RAILWAY AND THE RAILWAY SYSTEM OF SOUTHWEST AFRICA.

TRACK AND BRIDGES.

The railway is built to a gage of 600 mm. (24 ins.). A great deal has been written from time to time for and against the railway lines of this gage, and Mr. Knight is of opinion that the Otavi Railway supports the arguments of the advocates of the 24-in. gage in a very forcible manner, as the results and the capacity of this line (the longest of its kind in the world), are better and far more satisfactory than could reasonably have been expected. When the troubles with the natives have settled down again, a considerable increase in freight and passenger traffic is to be expected. The freight carried daily varies from 200 to 300 tons, all the available rolling stock being employed. The capacity could be doubled and trebled without difficulty, by arranging for a larger number of sidings and for an increase of the rolling stock equipment. Even with an average tonnage of 1,000 tons daily, only 14 trains would be required; so that the railway has not yet nearly reached the limit of its capacity.

The rails are of T section 3⁹/₁₆ ins. (90 mm.)

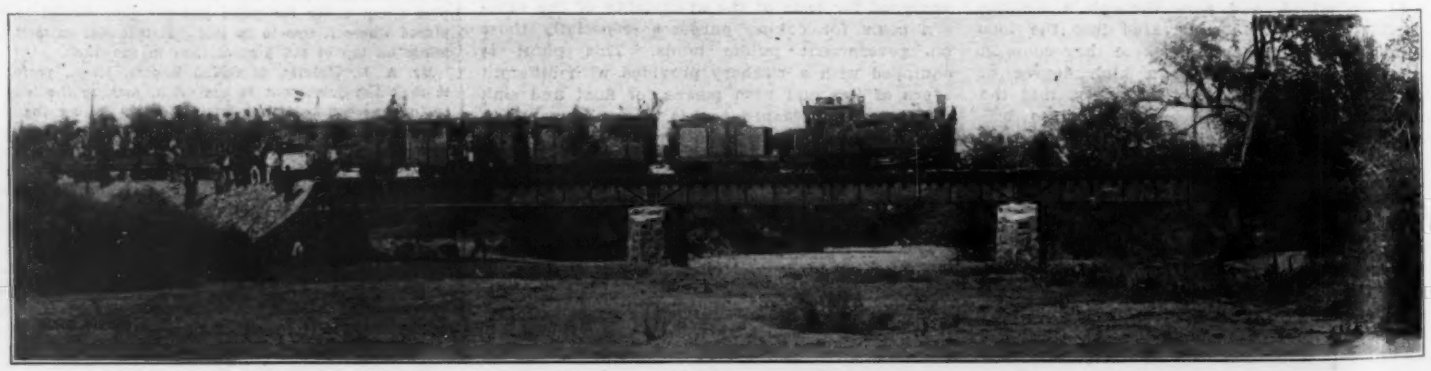

FIG. 2. BRIDGE AT ETIRO; OTAVI RAILWAY.
(Note inclined stiffeners; also splicing in middle of girders.)

*Bourne House, Copthall Ave., London, England.

high and weigh 30 lbs. per yd. (15 kg. per meter). They are 29 ft. 6 ins. long. The ties are of steel, of inverted trough section, 2 ins. deep. They are 4 ft. 1½ ins. long and are dished longitudinally to give the rails an inward inclination. They weigh 24 lbs. each. Each rail length of 29 ft. 6 ins. has 13 ties, spaced 26 ins. c. to c. These steel ties have been used throughout, except that on bridges the rails are laid on oak ties. The rails are fastened to the steel ties by means of steel clips, with bolts and nuts. The clips are of various sizes and allow the gage to be widened 0.96-in. on curves. The joints are spliced by plain splice bars 16 ins. long, with four bolts spaced 4 ins. c. to c. The track weighs about 100 lbs. per yd. In the tracklaying, each tie is carried by one man, and there are about six men to each rail. The ties on the subgrade are placed resting only upon their depressed ends, being ballasted and tamped after the tracklaying has been completed. All the switches and frogs are of a uniform construction, with No. 7 cast-steel frogs and a turnout radius of 164 ft. The turntables have a carrying capacity of 25 tons and a diameter of 14.75 ft. They have platforms made of chequered steel plates turning on 14 steel rollers, the center pivot serving as a support for the rollers only, so that the friction is reduced to a minimum. All the bridges are of steel, and they are designed for a carrying capacity of 6.5 tons per axle. There are 110 bridges in all, the longest being about 330 ft., composed of five spans of 65.6 ft. (20 m.). Fig. 2 is a view of the bridge at Etiro, having three plate-girder spans of 43.2 ft. The inclined stiffeners in the end panels of the girders will be noted. The piers and abutments are of stone masonry. The river-bed is shown practically dry. This view was taken on the day of the opening of the line, the train being decorated in honor of the occasion.

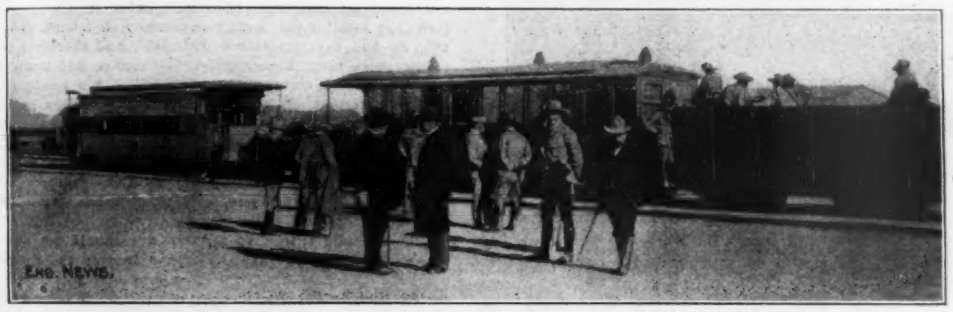

FIG. 3. MIXED TRAIN ON THE OTAVI RAILWAY; GERMAN SOUTHWEST AFRICA.

LOCOMOTIVES AND ROLLING-STOCK.

LOCOMOTIVES.—The first type of locomotive was of the 0-6-2 type, with coupled wheels and a trailing axle. The middle driving wheels have blind tires so as to facilitate passing curves. These locomotives are capable of hauling a gross load of 78 tons at a speed of 15.5 mi. per hr. on the level, or at 9.3 mi. per hr. up a grade of 2%. Owing to the increase in traffic, larger and more powerful engines were adopted later on. These can haul, exclusive of their own weight, a gross load of 100 tons at a speed of 25 mi. per hr. on the level, or at a speed of 9.3 mi. on a grade of 2%. The dimensions of these engines are given in the accompanying table:

LOCOMOTIVES OF 24 INS. GAGE: OTAVI RAILWAY.

	Class A.	Class B.
Wheels, driving	2 ft. 4 ins.	2 ft. 10 ins.
Wheels, trailing	1 ft. 10 ins.	1 ft. 10 ins.
Wheelbase, driving	5 ft. 7 ins.	6 ft. 4 ins.
Wheelbase, total	11 ft. 6 ins.	13 ft. 3 ins.
Weight, in working order.	22.7 tons.	22.8 tons.
Weight, empty	15.5 tons.	18.1 tons.
Length over all	23 ft. 6 ins.	25 ft. 0 ins.
Width over all	7 ft. 3 ins.	7 ft. 3 ins.
Height, rail to top of stack.	10 ft. 6 ins.	10 ft. 6 ins.
Cylinders	12 × 14 ins.	12⅝ × 18 ins.
Boiler pressure	176 lbs.	176 lbs.
Heating surface, total	495.00 sq. ft.	610.00 sq. ft.
Grate area	8.61 sq. ft.	10.76 sq. ft.
Water in boiler	330 gals.	350 gals.
Water in tank	770 gals.	220 gals.
Coal in bunker	1 ton.	¾ ton.
Tractive force	6,000 lbs.	8,000 lbs.

Owing to the scarcity of water, each train has a tank car. For this reason, the larger engines are not of the "tank" type, but separate tenders are attached carrying 2,640 gals. of water and 3.5 tons of coal each. Each engine has two injectors and a duplex pump. Altogether there are now 36 locomotives and 20 tenders on the line.

FREIGHT CARS.—There are numerous types of cars in use. The open cars were at first constructed as low-side gondolas, but this was changed and the cars supplied later on were fitted with high sides. The low-side cars have no doors, but are so constructed that the sides can be swung down. The sides of all open cars rest in sockets, and can if necessary be taken off. All these cars have a carrying capacity of 10 tons and a floor space of 81 sq. ft. They weigh 3.6 tons. The covered or box cars have a sliding door at each side, and the carrying capacity is also 10 tons, with a floor space of 83 sq. ft. They weigh 4.4 tons. To reduce the wheel load and to allow the cars to pass the curves with ease, each car is mounted on two four-wheel trucks. Each car has a brake applied to four wheels. The railway now has 132 low-side cars, 52 high-side cars, 20 box cars and 5 cattle cars. The State Railway running from Swakopmund to Windhoek, which is connected with the Otavi line at Swakopmund, has rolling stock with a different spacing of the buffers, and to allow of the cars of the two lines being coupled together, special cars have been designed with extra deep buffers. Ten of these are now in constant use.

PASSENGER CARS.—There are at present only three passenger cars. Each first-class car accommodates 12 passengers, 8 inside and 4 on the platform. The second-class cars have seats for 12 passengers inside and 4 on the platform. To make the cars secure against high winds, the space between the channels of the underframe has been filled with concrete, reinforced by iron bars, and the floor is about 6 ins. lower than the platform. Each car has a carrying capacity of 10 tons, and weighs 6.2 tons (inclusive of the concrete ballast). A private car has been provided for the inspecting engineer and the directors of the company. This car has a compartment serving as an office, a sleeping compartment (with three folding beds), bath room and kitchen. All passenger cars have four-wheel trucks, and are fitted with hand screw brakes worked from the platform. During the construction a number of motor velocipedes were used by the engineering staff. The rolling stock has been subjected to very severe service, but it is stated that at no time were more than 5% of the cars under repair. A freight train is shown in Fig. 2, while a mixed train standing at an up-country station is shown in Fig. 3.

The greatest difficulty that had to be overcome, besides the supply of labor, was the question of providing water, as already noted. No water could be found between Swakopmund and Usakos, a distance of about 93 miles, but even the water at these points could not be used for feeding the boilers without being previously softened. Water-softening plants had consequently to be erected. A large repair shop has been built at Usakos, for both the locomotives and rolling stock. The necessary power is supplied by a 40-HP. engine. A shop has also been built at Swakopmund, where all the imported rolling stock is erected.

THE COPPER MINES.

In the Otavi district, granite is believed to form the heart of the mountains, and there are limestone strata which are not related to the ore body. The outcrop at Tsumeb is said to be 550 ft. wide and 30 to 40 ft. high, consisting of two distinct bodies of ore separated by a hard compact limestone. The report of one expedition states that the mixture of ores constituting the outcrop is curious: galena, copper glance, and carbonates of both metals can be found in one piece of rock. The limestone shows some small seams of carbonate of copper, which at a greater depth proved to be copper glance. Along the outcrop, the ore deposits are about 590 ft. wide; at the third level (230 ft.) there is a greater development; the high-grade ore increases and the low-grade ore decreases at the greater depth. The thickness varies between 33 and 55 ft., not including the clay seams which are impregnated with ore and mixed with boulders, and which are prominent in the upper levels. In the undisturbed part of the deposit, the hanging as well as the foot wall occurs in conjunction with a clay seam. According to a paper by Mr. Knight in the "Engineering and Mining Journal," the high-grade ore is estimated to average 12% copper and 25.3% lead, while the low-grade ore averages 2.9% copper and 4.4% lead. The distribution of the ore in the deposit is very irregular, and on account of the varying ratios of the sulphides and carbonates of lead and copper no accurate estimate of the average metal contents can be made. The minerals in the formation consist of copper glance, malachite, azurite, galena, cerusite, a little zinc blende, calamine, clay and quartz. Analyses show also small amounts of antimony and arsenic compounds.

Experiments have shown that a separation and concentration of the lead and copper ores cannot be made by mechanical or wet means. A complete separation of these ores is also out of the question on account of the amount of carbonates present, which are too near each other in specific gravity to allow of proper concentration. But the massive character of the ore allows a hand separation and all low-grade material is eliminated, and direct smelting of the concentrate can be carried out. The massive character of the deposit permits a very complete winning of the mineral without loss. In order to win the high-grade outcrop mineral without excessive underground development, there is installed a mechanical equipment for hauling from open cuts along an inclined way. In addition to this, there is a main hoisting shaft sunk in the hanging wall of the deposit and connected with the surface work by an inclined crosscut. Through this shaft a part of the ore is hoisted. By this means, it will later be possible to attain the maximum daily production of 400 to 500 tons.

It is proposed to smelt the ores after sorting and to produce work lead and copper matte containing 40 to 50% copper; also to refine these products and ship metallic copper, lead and silver to Europe. Smelting operations are expected to be under way by the middle of 1907.

AN EXCEPTIONALLY DEEP COAL BORE is being sunk near Cameron Bridge, Scotland; before the mountain limestone was reached the bore was 4,500 ft. deep. Another deep bore has been made at Gilmarton, near Edinburgh, for Messrs. Wm. Baird & Co.; on Aug. 31, this bore was 3,000 ft. deep; it is 8 ins. in diameter at the surface and 1¾ ins. at the bottom. This bore has proven the existence of the lower coal measures in the east of Fifeshire. The Scottish Geological Survey expects to make tests and records of temperatures at the bottom of the bores.

MOTOR OPERATED VALVE EQUIPMENTS have been installed in the water-works at Cincinnati, Ohio. Each valve-set consists of the valve proper, a motor, an automatic limit switch and a switchboard panel. The limit switch is so designed that when the valve is at either end of its motion, the motor can be operated only in the proper direction. Thus, if the valve is open and it is desired to close it, the double throw switch on the panel is thrown over and the motor started. When the valve closes, the limit switch automatically opens the circuit and stops the motor. The motor can then be started only in the opposite direction. This is done by throwing over the double throw switch and restarting the motor. When the valve opens fully the limit switch again opens the circuit for that direction of motion. The valves are made by the Pratt & Cady Co., of Hartford, and the electrical equipment by the Crocker-Wheeler Co., Ampere, N. J.

A TRIPOD USED FOR SURVEYING IN THICK SCRUB.

By JOHN L. HILDRETH, JR.,* Assoc. M. Am. Soc. C. E.

The accompanying illustrations show a tripod and platform used in an extensive stadia survey through thick scrub, oak and pine on Long Island. In many places the growth was very heavy, and in one instance a rodman, when sent back for some tools, was lost and walked about for nearly an hour, although only about 400 ft. away from the instrument.

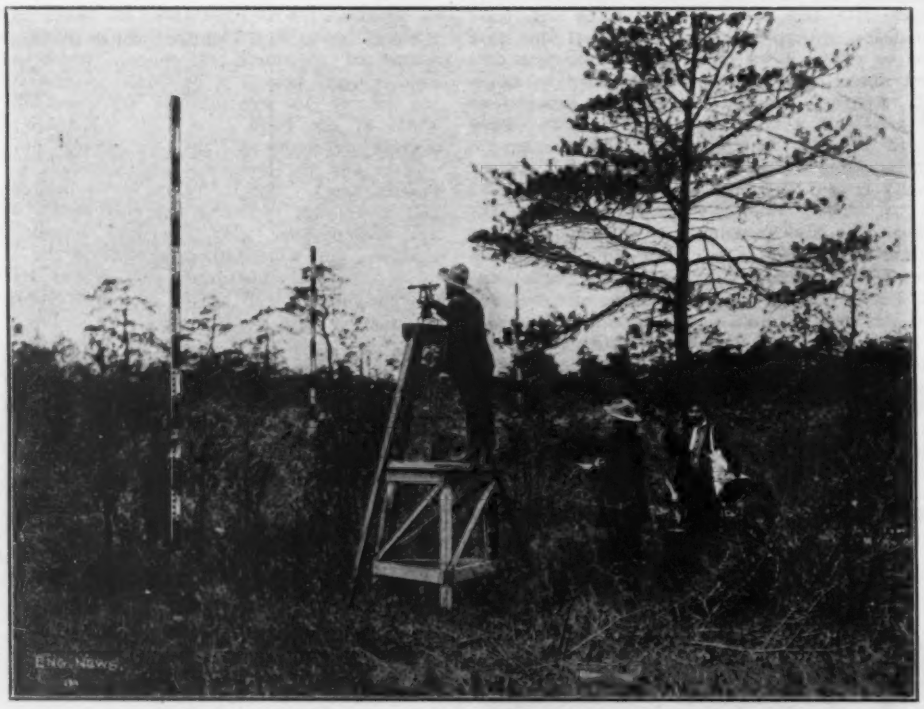

FIG. 1. ELEVATED TRIPOD USED IN THICK SCRUB ON LONG ISLAND.

The legs of the tripod are 8½ ft. long. The transit is set on a trivet on the tripod. This brings it about 9 ft. above the ground and over most of the scrub. The platform is 4 ft. high, and is set with the corners betwen the legs of the tripod. In order to secure the best results it is necessary that the tripod should be stiff, heavy enough to hold the instrument steady, and yet light enough to be easily moved, and the platform light, stiff and collapsible.

As shown in Fig. 2, the tripod is made of oak, except the two lower layers of the head, which are of white pine. The cleats which form the bearings of the legs are held to the head by ½-in. bolts. The six inner bolts are 1 in. longer than the rest, so that they reach through the stiffening piece on the bottom. All of these bolts are countersunk in the head so as to give a smooth surface on which to set the trivet. A hole in the head 5 ins. in diameter is found ample for a rapid set-up.

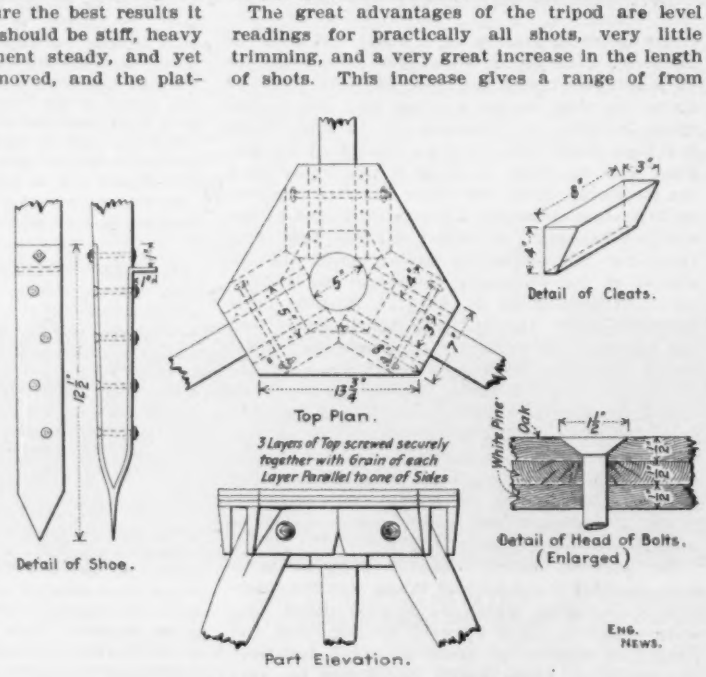
Detail of Shoe.
Top Plan.
3 Layers of Top screwed securely together with Grain of each Layer Parallel to one of Sides
Part Elevation.
Detail of Cleats.
Detail of Head of Bolts. (Enlarged)
White Pine
Oak
ENG. NEWS.

FIG. 2. DETAILS OF TRIPOD.

The legs are grooved to lighten them, and the shoes on their feet have a lip on the outside so that they can be driven into the ground to ensure a firm set-up. The platform, which is made of spruce, consists of two parts, the top and the stand. The former is built as shown and fastened to the stand by a hook at each corner. The stand is made of two panels held together by a 12-ft. tape for the instrument height. The stadia rods used are 16 ft. long, 4 ins. wide, 1½ ins. thick at the bottom and ½-in. thick at the top, with a 1 × 2-in. stiffening rib on the back. This usually gives from 6 to 8 ft. of the rod above the scrub, thus reducing to a minimum the chopping for all traverse lines and side shots.

The great advantages of the tripod are level readings for practically all shots, very little trimming, and a very great increase in the length of shots. This increase gives a range of from 600 to 1,000 ft., depending somewhat on the character of the ground, where with an ordinary tripod 300 ft. would be the maximum.

In many cases, unless the tripod is used, lines would have to be cut, or vertical angles used.

The half-tone shows a party in the field using one of these tripods.

*Assistant Engineer, Board of Water Supply, Babylon, N. Y.

MUNICIPAL OWNERSHIP OF PUBLIC UTILITIES.*

By JOHN W. HILL,† M. Am. Soc. C. E.

Why public water-works, should, of necessity, be under the control of the municipality, is not quite apparent. The most successful water-works, from the business point of view, are owned and operated by private companies, and while instances are rare where private parties have installed and operated a system of sewerage, nevertheless, it is altogether possible that even this might be made the work of a private company to the advantage of the municipality and of its citizens.

Before giving special reasons upon which the writer bases his objection to municipal ownership and operation of public utilities, it is well to point to the fact that the operation, by private corporations, of works of public water supply, electric lighting, gas, tramways, traction lines and railroads, surpasses in business respects the corresponding work of municipalities. It is well known that a dollar will go farther in purchasing supplies and fuel, and paying for labor, with the private enterprise, than it will with the same enterprise managed by public officials, and if this were not so, and there was any doubt of the success of management by private corporations of the great public utilities of the country, then the question could be seriously debated whether this country was not backward in adopting the socialistic doctrine of government ownership and operation of all the public utilities. It is not denied that some government, city and municipal work has been well done under the management of the public officials chosen by ballot at the polls or appointed by others who owe their office to election, but in every case where a municipality can show excellent work in the construction of a public utility, invariably it can be demonstrated that the same work could have been accomplished in less time and at less cost by a private institution working in its own interest.

Considering public contracts versus private contracts, the usual legal restrictions imposed upon a bidder and contractor for public works entail an increased cost without increased quality or efficiency; some of these conditions are born of the feeling that many if not all public officials and contractors are dishonest, and therefore the public purse must be carefully safeguarded and honestly secured by the enforcement of unreasonable conditions. Other restrictions in public contracts have grown out of the demands of trade unions for an eight-hour day, for the employment only of American citizens on public works, and the enforcement of other conditions in the interest of organized labor, all of which hamper the performance of work, increase its cost, and at times impair its quality.

Why a public official or a contractor should not be as honest as the groceryman, the baker or even the clergyman, has never been shown. If a man of dishonest bent should become an official or a contractor, it is possible that he might be inclined, when opportunity offered, to exercise his natural or ingrained talents. But so far as personal experience may be permitted to set up a standard, I believe that public officials and contractors, in point of honesty and integrity, will compare favorably with any other class of men.

However, any objection urged in this paper to municipal ownership and operation of public utilities, has no reference to the honesty or dishonesty of public officials, or contractors, but is based on entirely different grounds.

The exercise of personal judgment upon the quality of work performed and the conditions under which it shall be performed, as expressed in the written or printed specification for public work, is hampered by the restrictions placed upon the acts of public officials, and in the majority of cases where public officials have been charged with misdemeanors, or worse, in the conduct of public work, if the same acts had been committed in behalf of a private corporation they would have been highly commended by their superiors, for the wisdom and business capacity shown in construing doubtful and obscure conditions of contracts and in settling disputed claims, or acts which under private management would be regarded as an evidence of business capacity in executive officers, are sometimes construed as crimes, if performed by a public official, in the interest of the commonwealth. It is for this reason, very largely, that the highest talent of the country is rarely enlisted in the conduct of public work.

The engineer or the business manager who realizes his ability to properly conduct the work assigned to him requires no laws, rules, or restrictions to honestly secure the highest result attainable, with the means and facilities at his command.

In a large public works, with which the writer was recently associated, involving an expenditure of more than $25,000,000, and embracing a line of works in some respects entirely new to this country, there was abundant evidence of a material increase of cost of works because it was conducted by a municipality rather than by a private corporation. In planning the works, officials above the writer in point of legal authority, having absolutely no experience in the technic or practice of the

*From a paper read before the Central States Water-Works Association, Wheeling, W. Va., September, 1907.
†First National Bank Building, Cincinnati, Ohio.

works in question, insisted upon recognition in developing details, and to secure peace in the official family, and move on with the work, many compromises were made at unnecessary cost to the city. The best results could not be sought by direct economical and efficient methods, in the interest of the public purse. The Director of Public Works and the Chief Engineers of two other Bureaus participated in the preparation of plans and details for which they had no training and upon which they were wholly unqualified to act, but by virtue of their offices they had to be recognized and consulted, and, in order to stamp their authority on the work, features of construction, expensive and useless, were frequently incorporated in the plans, solely to maintain the "entente cordiale" in the official household.

I do not think anything of this kind could have occurred in a private enterprise; instead of seeking ways of spending money, my experience with private corporations has been that every one in authority is striving to save it, and instead of enlarging and amplifying completed plans, the tendency is the other way. In providing for the water tightness of a reservoir, it should scarcely be necessary to use in liberal quantity imported puddle clay, and then paint the surfaces of the concrete lining with hot asphalt. If the puddle is worth anything, the asphalt coating will not be required; and if the puddle is not reliable, then why use it at all, and this especially where both puddle and asphalt coating were unusually expensive? Hundreds of tons of cast-iron water pipe were laid, and many stop valves placed, which use of the works showed had no function whatever, solely because one of the superior officers conceived a plan of operation which had never before been adopted, and now it is known will never be adopted. Numerous instances like this can be cited; but the most serious objection was found in building unnecessary structures, solely because one of the superior officers urged that even if they did no good they could do no harm, and therefore should be built. The harm done was to the fund provided for the work, which in a single instance amounted to 3% of the cost of all the works.

A private company could have carried out works of the same magnitude and efficiency at a saving of at least 20% in cost and a gain in time. However, the losses to the municipal corporation were not limited to unnecessary features of plan and construction, but were felt in the employment of inefficient, worthless and superfluous assistants, solely because some political leader wanted his "heelers" on the pay-roll. Draftsmen who could not draw, and inspectors who could not inspect were paid high salaries, and kept on the roll, because some political friend had passed the word that they should be. Such things may ocur in the conduct of a private enterprise, but I have never known or heard of it.

One of the worst features of public construction work is the organization of a band of political contractors in every large city, who parcel out the work among themselves, usually on their own terms, and who have facilities for preventing or stifling real competition at lettings.

The conscientious and untrammeled city official could refuse to award contracts when he believes collusion exists between contractors at a letting, and delay thereby the construction of important and necessary public works, and sometimes when he enjoys the full support of his superiors and associates he may be able to compel bidders to submit reasonable prices, but excepting government work, the authority to award or withhold contracts, or adopt methods which will compel bidders to submit reasonable prices, is not usually vested in the engineer for public work. This discretion and power is vested in an elected Board of Public Works, or appointed Director of Public Works, and while the engineer can offer recommendations and advice, he is powerless to act. In private work, the engineer usually is authorized to make the best contracts possible in the interest of his employers or clients.

In a speech at the dinner tendered to him by the Buckeye Club, at Columbus, Ohio, Aug. 10, 1907, Honorable Wm. H. Taft, Secretary of War in President Roosevelt's Cabinet, and one of the strongest forces in the Federal Government, to-day, upon the topic, "Government Ownership of Railroads," said:

> I am opposed to government ownership.
>
> First, because existing government railways are not managed with either the efficiency or economy of privately managed roads and the rates charged are not as low and therefore not as beneficial to the public.
>
> Second, because it would involve an expenditure of certainly twelve billions of dollars to acquire the interstate railways and the creation of an enormous national debt.
>
> Third, because it would place in the hands of a reckless executive, a power of control over business and politics that the imagination can hardly conceive, and would expose our popular institutions to danger.

The first and third objections to government ownership of railroads raised by Mr. Taft will apply with equal force to municipally-owned public utilities. Experience abundantly shows that they are not managed as efficiently or as economically as private corporations, and while the rates charged may be as low as or lower than the rates of private corporations, the service as a rule is inferior, and not as beneficial to the public.

Mr. Taft's third objection sounds funny; the reckless executive is in our municipalities to-day, was here yesterday, and will be with us to-morrow, to the end of time, and the millions of loss each year to municipalitits by public mismanagement of public works is not only conceivable, but is palpable, to one who cares to make the investigation.

Some months since, I made a declaration that under private management, or with unhampered control, I could reduce the cost of operating the water-works of one of our large cities at least $150,000 per year, whereupon the Board of Public Service at once took the necessary steps to prevent the proposed saving, by securing firmly in position all the political employees of the department.

Much has been written of the remarkable record of Hon. Carter H. Harrison, father and son, former mayors of Chicago, but Marshall Field undoubtedly could have made a record, as mayor, of which his friends and the city would have been proud, and it is doubtful if any one can seriously question the assertion that Mr. Field's career and success as a merchant is more impressive and pronounced than was the career and political success of the Harrisons. Mr. Field's qualifications were of such a high order that success awaited him in any walk of life where commanding talent and executive skill are required. As the founder and manager of a private enterprise, Mr. Field achieved a success which has not been surpassed, if equaled, by any contemporaneous public official from presidents down. This he did not because of greater ability than the more conspicuous public officials of his time, but because his work lay in channels free from politics, unhampered by the dictation or advice of associates or superiors ignorant of their duties. Mr. Field's associations were free from the pernicious influence of popular or partizan elections. His partners and subordinates were chosen for skill in their respective lines, not subject to the changes of the political kaleidoscope, secure in their positions and advanced in authority and salary, according to their merits. It is probable that their business qualifications were not better than that of many men elected or appointed to political office, but their opportunities of demonstrating capabilities were better.

If Mr. Field, and he is only a type of the many lines of commercial business upon which the prosperity and wealth of the country is founded, could not successfully conduct his remarkable business, after the manner of conducting our municipal business, by what process of reasoning can it be argued that our municipal affairs are conducted upon the plane of highest, or even high efficiency, when the average office holder is chosen not for fitness, but because of his claims for political recognition, because he has done or is expected to do some work which will place his party under obligations to him? If it can be shown that any public utility has been well conducted under municipal—which is only another name for political management—it will be an easy matter to show that it could have been better conducted under the management of a private corporation, both as regards cost and speed of execution, if a work of construction, and as regards cost and efficiency, if a work of operation.

During the past few months I have had occasion to collect statistics on the cost of steam power, and in support of the claim of better management by private corporations, advanced in this paper, it is found that even in the few cities having the highest type of triple-expansion pumping engines, and accessories to match, and in which the contract test and annual duties of the machinery are the best ever attained, the cost of power per year is greater than in the large well-managed steam power plants, owned and operated by the private electric and manufacturing corporations, and a comparison of statistics divided as to cost of fuel, labor, repairs and stores, show the excess cost to be principally in the item of labor.

In the following table, the figures represent the annual costs per indicated horse-power of prime movers: Coal figured at $2.50 per ton, excepting Hamilton, $2.20 per ton. City Water-Works, and Philadelphia Power, 8,760 hours; Pittsburg Power, 8,666 hours; Hamilton, 8,000 hours.

Nature of power		Fuel.	Labor.	Repairs.	Supplies.	Total.
City pumping works.	(1)	$15.70	$24.62	$5.96	$2.74	$49.02
"	(2)	17.44	25.19	5.25	2.58	51.48
"	(3)	16.70	24.01	1.28	2.05	44.04
"	(4)	16.75	21.90	1.85	1.88	42.38
"	(5)	16.82	26.19	1.17	1.59	45.77
"	(6)	21.39	15.64	9.62	1.24	47.90
"	(7)	18.89	.....	31.14	....	50.03
"	(8)	27.64	26.44	9.55	5.44	69.08
New York.....	(9)	25.55	13.13	5.90	1.42	46.00
Philadelphia	(10)	20.51	6.61	1.52	1.32	29.96
Pittsburg	(11)	19.51	4.42	3.55	2.50	29.97
Hamilton	(12)	16.90	5.18	0.88	0.64	23.62

It is interesting to note that the total cost of power by a private corporation, No. 11 on the list, is less than the cost of labor alone in the city water-works power, Nos. 1, 2, 3, 5, and 8. The figures are from the last annual reports. The costs of labor, repairs, and supplies are not known in detail for No. 7, but can roughly be stated as $25 for labor, $4.14 for repairs and $2 for supplies.

In each city pumping station, the engines considered are from the best known and highest class builders, and the water-works profession is accustomed to point to the cities considered as examples of excellent water-works management.

The average cost of labor in the eight city power stations is $23.62 per I. HP. per yr. for 8,760 hours, while the average cost of labor in the private corporation stations is $7.33, or about one-third the cost in the municipally-owned and operated stations, or to state the matter in different form, the city uses three men to do one man's work.

Engineers generally recognize the modern high duty triple-expansion pumping engine as the highest type of steam power, and the service of pumping at constant speed, against a steady head, to reservoirs, the "optimum" condition for high running duty. Moreover the long runs of pumping engines, without interruption for Sundays, are calculated to favor the annual economy, when compared with steam engines working under a constantly varying load, and, in all but traction and electric lighting stations, stopped altogether for Sundays and holidays.

The duties obtained on the trials of Engines 1 to 6, inclusive, are the highest in the history of pumping machinery, a fact well attested by the annual charge for fuel; indeed the fuel costs, on the average, are as good for the city-managed works, as for the private-managed works. But when you come to the labor charge, there is where the politician comes to the front in great shape. There could be no political advantage in being wasteful of fuel, but there is a decided advantage in future elections in being wasteful of labor.

Two men can cast two ballots, and three can do better, while the coal burned in the furnace cannot vote, and there is therefore no advantage in being prodigal with it.

After allowing for the favorable conditions of modern water-works steam pumping service, even then the cost of power in the best private works is less than in the best water-works under municipal management.

Instances can be multiplied of power costs under municipal and private control which will verify the low cost for labor for private control and the high cost for municipal control. And if compared on the volume of business transacted, it can be demonstrated in almost any if not all cities that the cost per unit of work performed or business conducted is much greater for the public business than for private business.

The least objectionable of public works which can be conducted by the public are the building and maintenance of sewers and sewage disposal works, the cleaning of streets and the collection and disposal of garbage, although in some large cities this work is now the subject of annual contract. Water-works, electric and gas works, trolley lines, and steam and hot water heating systems, works employing large numbers of people, and requiring skilled assistance, should be the subject of private construction and control under contract or franchise which will properly safeguard the interests of the public and prevent extortion or poor service.

Cities have been and can be robbed by public service corporations, but only with the aid and connivance of public officials. Standing alone, the public service corporations will be compelled to meet the obligations imposed on them by their franchises, and give the public the required service at fair rates. The legislature can pass laws and the city councils can pass ordinances giving away public rights, and the public service corporations may be the beneficiaries thereby, but the officials chosen by the people to represent them are the culpable parties in such transactions.

Nearly all of the larger cities have adopted Civil Service, as a means of obtaining and retaining, in municipal service, only competent officials and subordinates, but as a rule the civil service examinations are perfunctory, or dictated by political leaders in the interests of their supporters. Civil service may prevent the summary removal of good men, and it often operates to prevent the removal of incompetent and bad men, and is wholly lacking in municipal government, at least, in that feature of business which permits the managers of large enterprises to recognize and reward individual worth, by promotion, to positions of responsibility, and increase in salary.

The exercise of independence in plan and action so essential to the prompt and efficient conduct of private business, is not possible in public affairs.

A 16% STREET RAILWAY GRADE on Selby Ave., St. Paul, Minn., has been eliminated by a tunnel on a 7% grade. This was originally on a cable line, but when electric traction was introduced nearly ten years ago a counterweight system was installed. The capacity of the line operated in this way became too limited for the traffic requirements, especially since interurban cars have been run over this route. A double-track tunnel has therefore been built, 920 ft. long, with approaches aggregating 550 ft. The retaining walls of the approaches are of reinforced concrete, and the tunnel has a lining of the same material. The tunnel is 23 ft. wide, with a height of 15 ft. 7 ins. above the rails. It is of 11 ft. 6 ins. radius from the flat floor, the center point being about 4 ft. above the rails. The work was designed by Mr. George L. Wilson, M. Am. Soc. C. E., Engineer of the Twin City Rapid Transit Co.; the contractor was Mr. Geo. J. Grant, of St. Paul, Minn.

FILLS MADE FROM CARS RUNNING ON A SUSPENDED CABLEWAY.

Although the suspended cableway with a traveling bucket has become a standard method of making long, inaccessible railway fills, it is rarely that a cableway has been used as the framework on which to lay a track for the carrying of cars dumping on a fill. In this article we describe two of such outfits which have been used on different contracts of the same railroad, the Lake Erie and Pittsburg R. R., now under construction from Cleveland to Pittsburg. Although the same general principle was utilized in each one of these examples, the local conditions were different and the detail of construction were independently solved. The first was made over a deep marsh of too soft a nature for the maintenance of a pile trestle and the described method was adopted only after several other schemes had failed; the second fill was over a deep gorge with good solid foundations, and the cableway was adopted primarily because it seemed to be the cheapest and most efficient method.

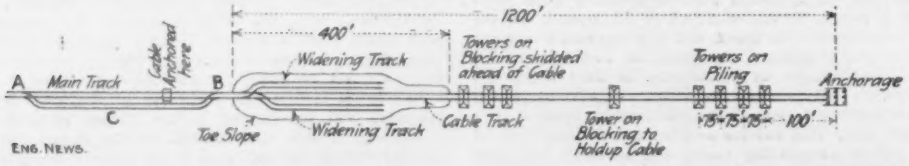

FIG. 1. PLAN OF TRESTLE AND CABLEWAY USED IN MAKING FILL ACROSS MARSH AT HUDSON, O.

FILL ACROSS MARSH.

About 25 miles south of Cleveland, on a portion of the contract under construction by Mr. F. A. Maselli, the line of the new railroad crosses a swamp on an embankment from 25 to 33 ft. high and 1¼ miles in length. The bottom lands across which the line is located are used for raising celery and are overlaid by a black, decomposed vegetable soil, incapable of sustaining any material weight. Soundings showed the greater part of the ground to have a mud crust about 15 ft. thick, then quicksand for 15 ft., then 10 ft. of soft clay overlying the hard blue clay bottom. At intervals the mud crust was only 15 ft. thick, and under it was a heavy underground stream flow so great that the water spurted several feet out of the sounding pipes. These subterranean lakes were so numerous as to make impracticable the ordinary methods of filling.

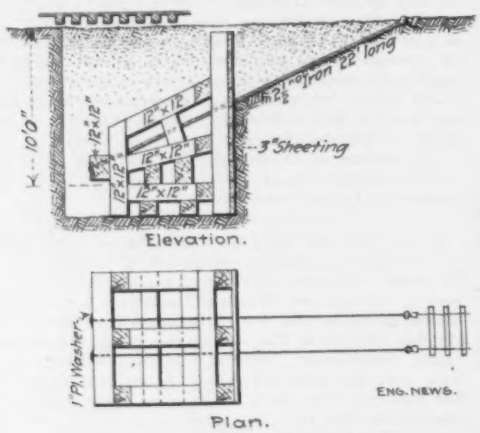

Fig. 3. Anchorage at Fill End.

The first attempt at crossing was made by laying crossed timbers on the muck surface and piling brush upon the grillage. Upon the brush a 5-ft. trestle was built, and the fill made from trains upon this. This method was successfully carried out for 600 ft., but one night the entire work settled under 6 ft. of water. It was then decided to build a pile trestle and attempt a fill by the ordinary methods. After five months of labor and at heavy expense this trestle was completed for 600 ft. The trestle consisted of bents of one plumb and two batter posts, spaced 15 ft. c. to c., braced with 3 × 8-in. planks and connected by 12 × 12-in. stringers. Each bent was founded on four piles, which were driven to hard bottom, sometimes 125 ft. deep. After this 600-ft. length was completed a test train was run on it, unloading material on both sides uniformly for the whole length of the trestle. This train consisted of one 16-ton locomotive and 14 loaded 4-yd. dump cars, an approximate weight of 112 tons. After dumping for 2½ days the trestle sank and became so deformed that this method of filling had to be abandoned.

At this time the third and last method was started. Two 1⅝-in. steel cables, about 5 ft. c. to c., were stretched from an anchorage in the fill already made over the nearest bent of the pile trestle remaining and on to the farther bents, to which the other end was anchored. Upon these cables ties were fastened, as shown in Fig. 4, and a track laid upon which the loaded cars were pushed and dumped, one at a time, at the end of the fill. The first span used was over 200 ft., covering the hole into which the trestle had sunk and which was at this time a pond of water 175 ft. long and 14 ft. deep. On account of the large span made necessary by the impossibility of driving a trestle bent in this pond, the sag in the cable was very great, and the instability of the cars quite marked. This, together with the great depth of the fill, necessitated the constant jacking of the track under the fill.

As soon as this sink hole was crossed a large trestle bent (Fig. 2) was erected, and the long span decreased by guy supports and timber grillage blocks. The material deposited in this hole (25,000 cu. yds. in a month) shoved ahead and completely carried away the remaining portion of the pile trestle which was serving as forward anchorage for the cableway. Timber towers were then built ahead and blocked up and skidded forward as the work progressed. This is the manner in which the work is now being carried on. Permanent towers, founded on piles, have been erected far ahead of the work to act as anchorages, and the movable towers are used as supports for the cableway.

Fig. 1 shows a layout of the work. A train of 14 loaded cars is run to the fill, seven cars are left on the main line, AB, and seven are carried around switch C and dumped. The engine takes these cars back to the main line and then pushes the whole train, with the seven loaded cars in front, down track AB to the dump. The two widening tracks shown are used only at night, the daylight being utilized for the switching ahead work. The work is being carried on in two shifts, 3:30 a. m. to 12 m., and 1:00 p. m. to 9:30 p. m., the intervening time being used to jack up the track under the fill. Approximately 40,000 cu. yds. per month are now being placed; the largest amount handled in a day shift of ten hours was 404 4-yd. cars. Figs 2, 5 and 6 show the train of cars dumping from the cableway and, Fig. 5 especially, the extremely soft nature of the ground.

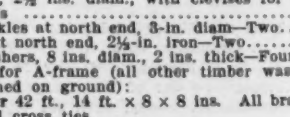

Fig. 4. Method of Fastening Ties to Cable.

Mr. R. G. Hengst, Assoc. M. Am. Soc. C. E., is superintendent on this work. He has had full charge of all construction, and to him is due the design and execution of the successful method of making the fill.

FILL ACROSS GORGE.

About seven miles south of Cleveland, on the contract held by the Williams Bros. and Morse Co., of Cleveland, O., the line of the railway crosses a gorge where a fill 400 ft. long and 95 ft. deep had to be made. After a careful estimate as to the relative costs of a pile trestle and a cable railway, Mr. A. E. Williams, of the contracting company, who was in charge of the work, decided to employ the latter method.

In this instance there was no trouble anticipated or found with the foundations. Two small trestle bents were erected at each bank and a tall intermediate bent in the center. Over these three, two 2¼-in. galvanized bridge cables were stretched 7 ft. apart, and anchored at either end onto logs placed in excavation and filled over. The rails rest on ties, spiked to stringers, resting in turn on heavy logs tied to the cables in the same manner as in the first example (Fig. 4). The fill is also made in practically the same way as in the first noted instance, small trestle bents being put in under the track as the fill advances to the center. As the conditions here are much firmer than on the Maselli contract, the whole system is much more stable. Turnbuckles are placed in the line of cable, by the use of which the suspended track may be kept taut. The fill is being made of crushed sandstone, to the amount of 175,000 cu. yds., taken from an excavation about a half mile distant.

Fig. 6 shows the fill in process of construction.

There follows a detailed cost account of the cableway together with the estimate made on the probable cost of the ordinary pile trestle for the work.

COST OF AERIAL CABLE ROADWAY.

2¼-in. Roebling galvanized bridge cable, 1,000 ft.	$900.00
Eyebolts, 2½ ins. diam., with clevises for both ends	108.30
Turnbuckles at north end, 3-in. diam—Two	120.00
Chains at north end, 2½-in. iron—Two	62.40
Cast washers, 8 ins. diam., 2 ins. thick—Four	2.46
Timber for A-frame (all other timber was obtained on ground):	
Upper 42 ft., 14 ft. × 8 × 8 ins. All bracing and cross ties.	
3,800 ft., at $34 per M.	108.80
Lower 50 ft., round timber, 56 ft. long:	
Bough in tree	32.00
Cost of team work for hauling round timber, and pulling timber to place for erecting	65.00
Carpenter labor on A-frame and end bents on bank	231.40
Time of superintendent, getting material and overseeing work in general	60.00
Common Labor:	
Digging trenches for anchors and putting up cableway	112.00
Nails and iron in A-frame and bents	29.40
Total cost of cableway	$1,531.76

ESTIMATED COST OF TIMBER TRESTLE.

Timber (all uprights, planks for bracing, stringers, etc.), 98,000 ft. at $26 per M.	$2,548.00
Labor, at $6 per M.	588.00
Spikes	98.00
Iron drift bolts	40.00
	$3,274.00
Balance in favor of cableway	$1,742.24

MUTUAL REINFORCEMENT OF WATER-WHEEL GOVERNORS.

By B. F. GROAT.*

A governor in good condition and good adjustment is a necessary appendage to a water wheel in a power plant where close speed regulation is required. It has been common practice to have an independent governor unit with each power unit. Where hydraulic governors operated by a liquid discharged through cylinders from pressure to vacuum tanks are used, the argument for such independence has been that a break in one governor will not necessarily interfere with the other power units and their governors. Some

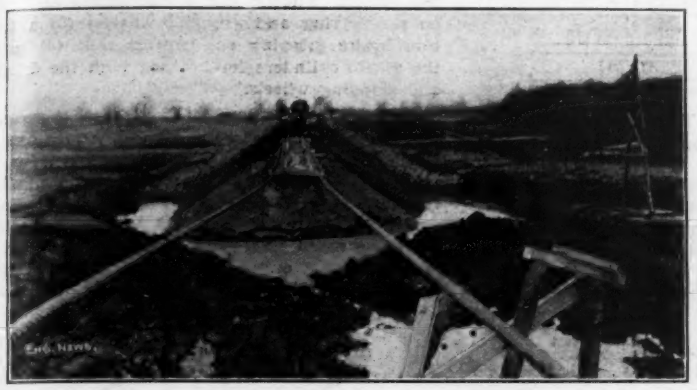

FIG. 5. VIEW LOOKING TOWARD FILL, SHOWING NATURE OF THE GROUND.

FIG. 6. ANOTHER VIEW OF THE FILL.

makers have declined to recommend a central oil pump and reservoir to supply pressure oil to a group of such governors in the same plant on this ground.

The operation of several governors of this kind has recently come under the observation of the writer. These governors had been in constant operation for more than ten years and when properly cared for and kept in repair had given excellent satisfaction. But a governor, like any other

FIG. 7. VIEW OF SUSPENDED CABLE ROADWAY ON THE WILLIAMS BROS. & MORSE CO.'S CONTRACT.

delicate piece of machinery, requires intelligent care. In time valves and valve seats wear so that valves will "stick" at that part of their travel which is least used. This point is frequently at wide-open gate, the most dangerous point for sticking. In many forms of governors sticking occurs just after a considerable movement of the regulating mechanism. This causes a drop in pressure at the pressure supply tank and the residual pressure is not then sufficient to overcome the sticking. In this condition the governor will work upon full tank pressure, but not upon some lower pressure.

In order to insure against such troubles, and all other troubles either proximately or remotely due to low pressures, the writer makes the following suggestion for pipe connections for mutual reinforcement of hydraulic governors operated as indicated in the opening paragraph:

Take a hypothetical case of ten governors, all on the same level. Assume, then, principal dimensions to be: Length of pressure tanks, 5 ft.; length of vacuum tanks 2 ft. (diam. 1 ft. each); main cylinders 2 ft. long (6-in. diam). If the pressure tanks are half full of oil, as they should be; the volumes of the air storage spaces are about five times the volumes of the main cylinders. Hence, neglecting leakage and the oil consumed by the smaller valves, and considering the air to expand adiabatically, we would have a ratio of expansion of 5 to 6 and a resulting ratio of pressures of 7 to 9. This results in a drop of tank pressure of about 23% per stroke of the main governor piston.

Let there be provided, however, two high-level lines of piping above the governor tanks and two low-level lines under the tanks. Connect one high-level and one low-level line with the pressure tanks at the top and bottom, respectively, and do the same with the other high and low-level lines and the vacuum tanks. This arrangement would constitute a mutually reinforcing system of governors, which would not be subject to troubles resulting from reduced tank pressure, and would secure two great advantages. First, there would be a uniform distribution of oil and air with a resulting expansion of about 2% per stroke of a single governor, neglecting the volume of the piping, which would tend to reduce the expansion and to increase the pressure still more. This resultant expansion would give less than 3% drop in pressure per stroke of one governor. Should all the governors work at full stroke simultaneously we would have merely the gain due to the piping, which, however, can be made as large as desired by introducing a reservoir. In any case, the volume of piping alone might well equal that of the tanks. This would give a drop in pressure of only about 12% per full stroke of all ten governors at once. As the second important advantage it is seen that the governors would mutually reinforce each other, especially as to pumping the oil. This reinforcement is greatest when a single governor cylinder is thrown into action, when the oil level in the vacuum tanks of all the governors rises and ten pumps instead of one restore the pressure. If the pumps were operating at unequal capacity the pressure reservoir pipe lines would equalize the distribution of oil in the pressure tanks.

At the same time any one governor would operate its cylinder independently of any one or all the other governors, and if desired could be cut off by proper valves from the pipe system for repairs, cleaning, etc.

Such piping arrangements as herein indicated would promote a more satisfactory operation of any installation of governors, and would enable them to run longer without the necessity of repairs, than a strictly separated unit system. In particular, the pump of any governor might be cut out without shutting down and without interfering with the regulation of the corresponding power unit or units.

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4,000 BBLS. OF FUEL OIL DAILY are being taken from the Mexican Petroleum Co. by the Mexican Central Ry., for use on its oil-burning locomotives. The road is increasing its number of oil-burning locomotives, and all new locomotives purchased are so equipped.

THE AMERICAN LOCOMOTIVE CO.'S annual report for the fiscal year ending June 30, 1907, embodies in part the following figures:

	1905-6.	1906-7.	Increase.
Gross earnings	$49,515,486	$42,547,876	$6,967,610
Manufacturing, maintenance and administrative expenses	42,744,381	36,085,370	6,659,011
Net earnings	$6,771,105	$6,462,506	$308,599
Interest, etc., on bonds of constituent companies; bills payable, etc.	412,898	281,812	131,086
Profits	$6,358,207	$6,180,694	$177,513

Out of the profits have been paid the regular dividend of 7%, or $1,750,000, to holders of preferred stock; and also dividends, aggregating 5%, to holders of common stock. In the year 1906-'07 the company's output and the volume of business transacted was the heaviest in its history. Its capacity for handling future business, moreover, has been substantially increased by the erection of new shops, power plants, machinery and equipment—mainly at Schenectady, Dunkirk, Richmond and Montreal.

THE PUY-DE DOME MOUNTAIN RAILWAY.

Various projects have been put forward for a railway ascending the mountain peak of the Puy-de-Dome, in France, but failed to materialize until the project of Mr. Claret was carried out, the line from Clermont-Ferrand to the summit being completed in August, 1906. The main difficulties were that the line had to overcome a considerable elevation from its lower end, and that it had to be built in material which is difficult to maintain both in banks and cuts. The system of traction which has been adopted is the Fell friction-grip central-rail system, first employed on the railway crossing the Mont Cenis pass before the construction of the Mont Cenis tunnel, and afterwards in a few other cases, including the Kadugawanna incline in New Zealand. The article on the Puy-de-Dome railway in the March number of the "Revue Generale des Chemins de Fer," from which our description is taken, terms this the Hanscotte system and states that it was introduced on the electric tramway at La Bourboule in 1904, Mr. Hanscotte having effected some modifications on the Fell system. The horizontal wheels gripping the central rail (elevated above the track rails) give increased traction in ascending steep grades and also prevent the derailment or overturning of the cars. The system admits of very sharp curves, is said to be economical as compared with rack-rail systems, and the center-rail can be omitted at road crossings. At these crossings, the front pair of grip wheels engages with the rail on the far side of the road before the rear pair has passed off the end of the rail at the near side. The distance between the two sets of wheels is about 14 ft.

The road is about 9.3 miles long, and has an elevation of about 1,266 ft. above the sea level at the lower end, and 5,290 ft. at the summit. The grades are from 2½% and 5% to a maximum of 12%; this last is continuous for about three miles just below the summit; the center-rail is used only on grades of over 6%, which aggregate about 5¼ miles. There are 134 curves of 130 to 6,560 ft. radius. The track is of meter gage, with 50-lb. steel tee rails on wooden ties, and the ballast is filled in to the tops of the rail webs, as shown in Fig. 1. The center-rail is a 54-lb. double-headed rail, laid flat, with its web supported on pedestals attached to the ties by screw spikes; the center line of this rail is about 6 ins. above the heads of the track rails. It is tapered to a wedge form at the ends to allow of the easy engagement of the horizontal wheels. Where rails is 12.63 ft. for the locomotives and 11 ft. for the cars. The locomotives are small tank engines of the 0-6-0 class, with outside cylinders, having the connecting rods attached to the rear wheels. Two water-gage glasses are used to show the variation of water level in the boiler

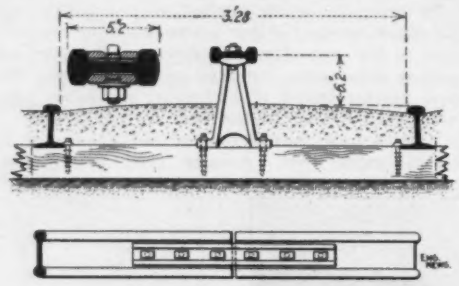

Fig. 1. Cross-Section of Track of the Center-Rail System, Puy-de-Dome Mountain Railway, France.

on the grades. The engine is always at the head of the train and is always run with the cab in front, so as to give the engineman a good view of the road. The general arrangement is shown in Fig. 2, while the mechanism of the horizontal wheels is shown in Fig. 3. At each

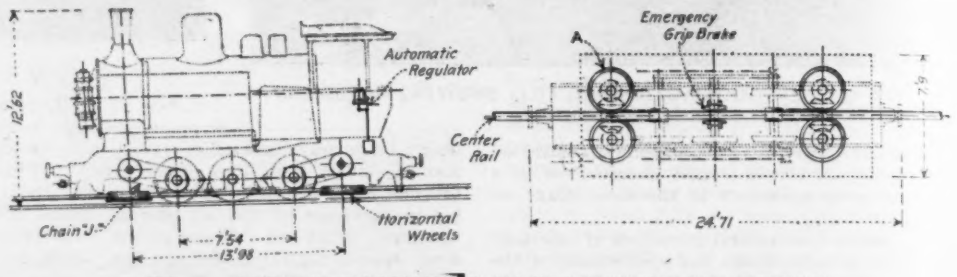

FIG. 2. GRIP RAIL LOCOMOTIVE OF THE PUY-DE-DOME RAILWAY.

end is a pair of horizontal wheels, A, flanged on the lower side to hold them in place on the rail; these are mounted on shafts, B, with the bearings C and D on the supports E, E; these are carried on the rollers F, which can slide in a transverse direction between the guides G, forming cross braces between the engine frames. Each wheel has an annular oil space, H, while the recess and flange at I prevent the oil from reaching the rails. The horizontal wheels are gripped against the rail by a system of levers, applied against them by means of levers connected to the brake system, as shown in Fig. 5. These wheels also hold the cars upon the track during severe winds.

The engines weigh 32 tons, and the train of three cars weighs 27 tons. The trains can run at speeds of 19 miles an hour on 3% grades, and eight miles an hour on grades of 11½%. The dimensions of the engines are as follows:

Wheels, adhesion (6)	2.95 ft.
Wheels, gripping (4)	2.69 ft.

The grip of the horizontal wheels upon the rail can be varied according to the grade, weight of train, condition of rail, etc., and is effected by levers connected to shoes, O, on the outside of the horizontal wheels. The supply of air to the cylinders of the gripping apparatus is automatically regulated in accordance with the grade of the line by means of the apparatus shown in Fig. 4. Attached to the rear end of the frame is an oil chamber, A, in which floats a pendulum weight, B; the arm, C, on the pendulum rod operates the T-lever, D, upon the center of which rests the stem of the distributing valve in the chamber, E. The engine is fitted with the following system of brakes: (1) Hand brake on the driving wheels; (2) a continuous air-brake on the driving and gripping wheels; (3) a friction brake gripping the central rail; (4) using the steam cylinders for braking both the driving and gripping wheels.

The cars are somewhat similar to those employed on street railways and light railways in Europe; the closed cars have capacity for 40 passengers inside and 10 on the platform, while the open summer cars seat 40 passengers. Each car has one carrying axle and one truck, the latter being fitted with horizontal wheels for braking purposes only. These wheels are held against the rail by springs, and brake shoes are

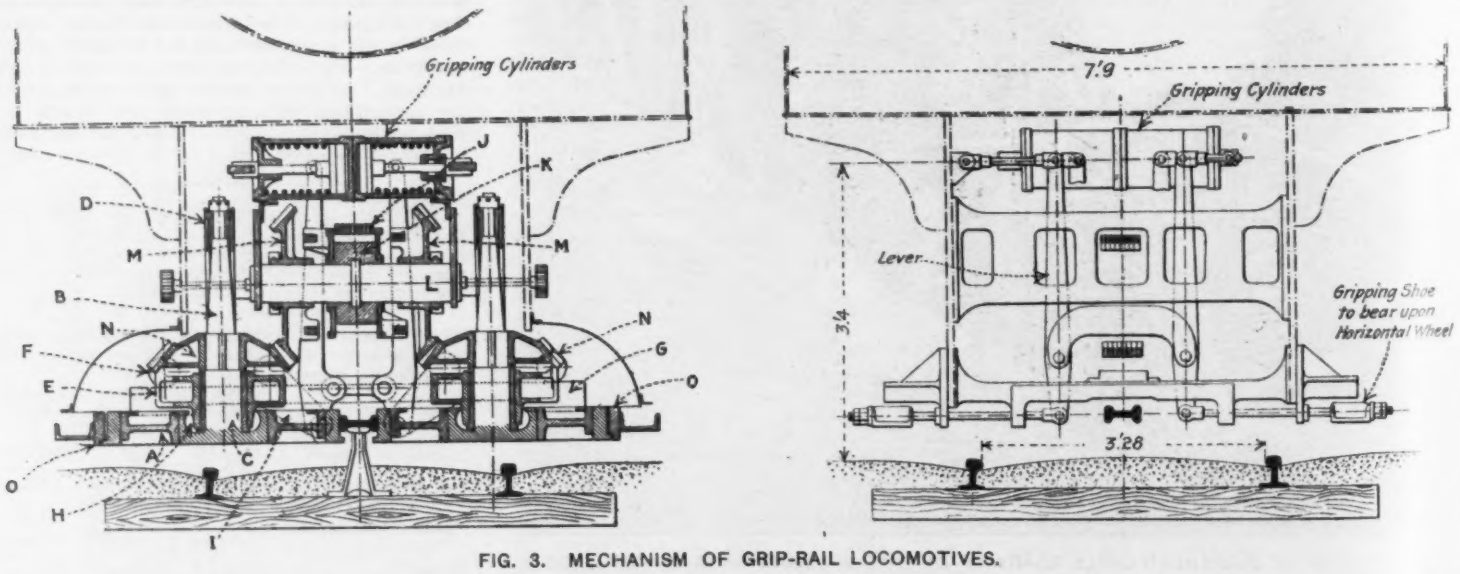

FIG. 3. MECHANISM OF GRIP-RAIL LOCOMOTIVES.

the line is laid along the highway it occupies the waste ground at the side, and at grade crossings (which are either on horizontal or low-grade portions of the line) the rail is omitted for a certain distance, as already noted.

There are 5 steam locomotives and 12 cars. The maximum width of the equipment is 7.87 ft., and the maximum height above the track connected to the supports E, and operated by compressed air cylinders. Each pair of wheels is driven from the nearest axle by a silent chain belt, J, and sprocket wheels. The chain wheel, K (Fig. 3), is on the middle of a cross shaft, L, having at each end a bevel wheel, M, which gears with a similar wheel, N (17.2 ins. diameter), on the vertical shaft of the grip wheel, A.

Wheelbase	7.54 ft.
Distance c. to c. of shafts of gripping wheels	13.98 ft.
Length over buffers	24.71 ft.
Weight	32 tons.
Pressure on grip rail	0 to 30 tons.
Cylinders	16.8 x 23.8 ins.
Cut-off, working with adhesion only	20%
Cut-off, working with grip-wheels	40%
Heating surface	774.75 sq. ft.
Grate area	14.55 sq. ft.
Height, rail to top of smokestack	12.02 ft.

ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.

The fourteenth annual convention of this Society was held at Detroit, Oct. 1 to 4, the meetings being held at the Cadillac Hotel and the Museum of Art. The attendance was very small, and the meetings were so late in getting started that (with the time spent in excursions) the sessions were too short to allow of proper consideration of the extended list of papers and reports. Comparatively little interest appeared

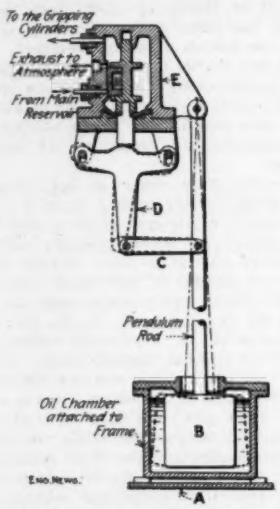

Fig. 4. Apparatus for Automatically Regulating Supply of Compressed Air to Gripping Cylinder.

to be taken in the subjects presented, except by a few members, and there were no such extended discussions as might have been expected at a meeting of municipal engineers. The first meeting was to have been held Oct. 1, but the attendance was so small that it was adjourned until the next day, being called to order about 10.30 a. m. by the President, Mr. M. R. Sherrerd (Newark, N. J.). The address of welcome was delivered by Mr. D. E. Heineman, President of the City Council, and was responded to by Mr. James Owen (Montclair, N. J.), First Vice-President of the Society. The President then read the annual address, which was brief and outlined the problems encountered in municipal work. He advocated the elimination of politics in the conduct of public works and engineering departments. This is largely effected by the introduction of the civil service system, but due weight should be given to a man's practical experience. It was also suggested that the municipal engineer should act in an advisory capacity to the different public boards, rather than be a member of such boards.

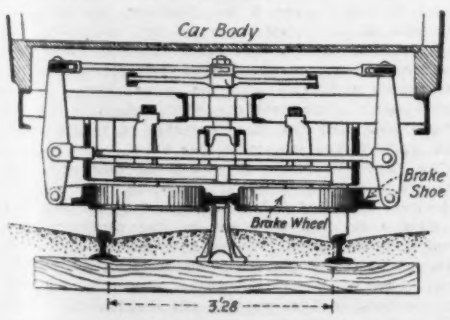

Fig. 5. Horizontal Guard Wheels and Brakes on the Cars of the Puy-de-Dome Mountain Railway, France.

STREET CLEANING.—The first paper was by Mr. C. F. Aldrich, Superintendent of Streets, Detroit, on "Street Cleaning Methods Used in Detroit." In this he enlarged upon the injurious effects of dust which is inhaled or which contaminates food exposed for sale, and he believed that the paving of alleys in cities would greatly reduce the throat, lung, nose and eye trouble. The city of Detroit has for two years been flushing 1,250,000 sq. yds. of brick and asphalt pavement, with marked benefit to the public health. He did not believe in the complaint that flushing with water at high pressure would injure the paving, except that with cedar block paving not thoroughly grouted the water will get under the paving and wash out the gravel.

The streets of the business section are flushed twice a week and others once a week. The flushing teams work 12 hours and are run in pairs; the inspectors work 8 hours; they handle the hose at the hydrants and supervise the work. There are four flushing machines, which are worked day and night; four more have just been purchased. During the past summer the department has been flushing 1,300,000 sq. yds. and sweeping 4,275,000 sq. yds. In future it will flush all the brick and asphalt pavements, amounting to about 3,000,000 sq. yds. During the summer about 100 men are employed to sweep up the horse droppings. The catch-basins have to be cleaned a little oftener when the streets are flushed, as the heavy rush of water will carry all the sand and dirt into the basins; but only the sand remains, the light dirt going into the sewer, as in a rainstorm. When the flushing wagon gets a few yards from the sewer opening the sand will settle on the pavement at the curb, to be removed by the dirt wagons.

As to the action of water on the pavement, I made a test by placing brick inside a wooden frame and slushing the crevices with the usual proportions of cement and sand. After two weeks, this was put under a stream of water at 30 lbs. pressure for over 48 hours. This represents more washing than a pavement would receive from flushing in three years, and the wear is hardly noticeable.

Mr. A. P. Folwell remarked that in ordinary flushing by machine the dirt is washed to the gutters and there left, to be afterwards gathered up and removed. A method employed in one city was to use old fire hose and wash all the dirt down grade to the sewer catch-basins and thus dispose of it at once. Mr. C. C. Brown said that the effect of water upon the paving depends upon the force and direction. At Indianapolis, experience has shown that a low pressure and an almost horizontal direction give the best results. He also called attention to the fact that the cleaning and washing of sidewalks is generally neglected by cities, but he considered the sidewalk dust more deleterious than that of the roadway. A short paper by Mr. C. D. Pollock (Brooklyn, N. Y.), reviewing the year's progress in street paving and cleaning, referred to the advantages of dust-laying preparations, as they give lasting results, while sprinkling with water only lays the dust during the day and while the surface is damp. He also considered that municipal asphalt plants were advantageous in giving the city control of the prompt repair of holes and openings, even though the work may cost rather more than if done by contract.

SEWERAGE AND SEWAGE DISPOSAL.—A paper on the sewerage system and disposal works at Kew Beach, Toronto (Canada), was read by Mr. C. H. Rust, City Engineer of Toronto. An abstract is given on another page. Mr. Rust also presented the report of the Committee on Sewerage and Sanitation, which is the committee's first report since 1902. The disposal works at Birmingham (England) were described:

While a number of small places dispose of their sewage by septic tanks and bacteria beds, no large plants similar in magnitude to those at Birmingham and Manchester (England) have yet been installed in America. From the experience in England it appears that much better and more satisfactory results are now obtained from filter beds. Where the sewage is distributed either by revolving sprinklers or by jets, it has been found that a much greater quantity of sewage can be treated per acre than by the contact beds. While at Columbus, from the results of the experiments it has been decided to distribute the sewage by means of jets, we doubt very much whether this method will be a success in the more northern parts of this continent.

When septic tanks were introduced a few years ago it was assumed that the sludge problem had been solved. This, unfortunately, has not proved to be the case, and while the introduction of septic tanks has minimized the problem to a large extent, as compared with the precipitation system, there is still a considerable amount to be dealt with. It has been considered that the sludge from septic tanks would create a great nuisance if put upon land, but this has not been found to be the case at Birmingham. With regard to the capacity of the septic or sedimentation tanks, the requirements are now considered to be too high. At first they were designed of capacity equal to 1½ times the daily dry-weather flow. This was later reduced to one day's dry-weather flow, and a number of engineers are now satisfied that 12 to 15 hours is sufficient.

The report referred to the growing use of concrete instead of brick for sewers, and to the frequent insufficient capacity of sewers, especially in cities having a large percentage of paved streets. It was suggested that members could do valuable work by keeping records of rainfall and run-off.

A long paper on "Phenomena of the Crushing of Sewer Conduits," by Mr. James N. Hazlehurst (Mobile, Ala.), was presented by the Secretary, but in view of its length it was not finished or discussed. As a result of several years experience with the breakage of sewer pipe, he had recommended that at Tampa, Fla., cast-iron pipe should be used in the deepest trenches (averaging 14 ft. for several miles). Owing to the increased expense, however, the board of public works refused to make the change or even to allow the change from standard thickness to the so-called double-strength vitrified pipe. The result was that the outfall sewers were found to be running full of ground water; and upon being uncovered "long stretches of the larger mains were found to have broken in longitudinal slabs," falling apart as the work was opened up. Cast-iron pipe was then adopted. Pipe may be broken with a shallow cover and heavy tamping. Where a 6-in. cover of loose earth was permitted before tamping, and a 40-lb. tool 8 × 8 ins. was specified, the breaks were numerous; by increasing the cover to 12 ins. and reducing the weight of rammer to 30 lbs. not a single joint failed. The important conclusion was as follows:

The writer is of the firm belief that under normal conditions the use of unprotected vitrified clay pipe should be limited to (and including) 15 ins. diameter. Beyond that and including 24-in., standard sewer pipe encased in a lean concrete up to its springing line and then beveled off at 45° is good construction. Reinforced concrete pipe of 27, 30 and 33 ins. diameter can be economicialy manufactured, preferably on the line of the works. Sizes of 36 ins. and larger should be o brick or continuous construction, depending upon soil, labor, available materials and other limiting conditions.

With the smaller sizes of vitrified sewer pipe far greater attention should be given towards securing an impervious connection, with experimental effort toward an elastic, permanent and non-rigid joint composition. The more careful work, while necessarily augmenting the cost, would (in the final analysis) permit safe estimating, while the elimination of the element of ground water to be provided for, would more than compensate for increased unit prices.

The evening session did not begin until after 8.30, and was opened by an interesting address on the city of Detroit, by Prof. A. H. Griffith, Director of the Museum of Art. He touched on some of the special points in the early history of the city (dating back to 1610) and in the development of its design under the plans of Mayor L'Enfant, who laid out the city of Washington. Dealing with modern improvements, he alluded to the failure to utilize the great opportunities of the river front, and suggested the construction of a handsome masonry esplande, as at Paris, London and Antwerp. He thought that if a beginning was made for one block, 300 ft., the advantages would be so apparent that the people would at once demand its extension. His remarks dealt with municipal improvements on a large scale, with an eye to the future, and he pointed out that most improvement work in this country is planned and built only for the present.

Several papers were then presented in a somewhat hurried manner, but there was no time for discussion. These included two by Mr. J. W. Howard (New York), on "Specifications and Tests for Paving Brick" and "The Density of Pavements as an Important Element in Their Durability." A paper by Mr. Wm. A. Howell (Newark, N. J.) dealt with an investigation of various bituminous materials used in expansion joints of brick pavements. There was also a paper by Mr. F. P. Smith (Chicago) on the disposal of garbage.

At a short meeting on the morning of Oct. 3, electric lighting matters were considered, and Mr. Wm. M. Daly, General Superintendent of the municipal electric lighting system of De-

troit, presented a paper reviewing the development of the system and giving an analysis of the cost of operation and service. The municipal plant at St. Joseph, Mo., was also mentioned in the report of the Committee on Electric Street Lighting, which had been prepared by Mr. E. A. Fisher, City Engineer of Rochester, N. Y. Mr. Fisher also presented a paper on "Ornamental Street Lighting," referring to the use of ornamental posts with groups of lamps.

In the evening a long session was held in an endeavor to clear up the program, as so much time had been lost. It did not adjourn till 11.30, when barely a dozen members remained. A paper on the municipal electrical conduits system at Auburn, N. Y., was first read, and was followed by an address by a delegate from the National Municipal League. This led to some brief discussion as to the two associations cooperating in their work, and also as to their possible affiliation. A paper on "The Guarantee Clause in Paving Specifications at Chicago," by Mr. John B. Hittell, was read by the Secretary, and provoked a brisk discussion. The general opinion was unfavorable to the guarantee system; Mr. James Owen stated that for some years he had omitted this form of specifications for road work; another member considered that the best and most economical results would be obtained by a continuation of good material, good work and careful inspection. Mr. Geo. W. Tillson (New York City) read a paper on wood paving, which is abstracted below; and then a paper by Mr. Geo. T. Warren on "Backfilling Trenches" was read. This should have produced a good discussion, but was passed by in order to close the proceedings. Mr. Horace Andrews (Albany, N. Y.) read the report of the Committee on City Government and Legislation, and it was then voted that the remaining papers should be read by title.

TREATMENT OF WOODEN BLOCKS FOR PAVING.

This paper, by Mr. Geo. W. Tillson (New York City) pointed out that the use of pavements of treated wood blocks has obtained considerable popularity within the past few years, and its development is a matter of interest. The object of the introduction of chemicals is two-fold: (1) To prevent decay; (2) to maintain stability in the size of the block, so that the pavement will not bulge when wet or have open joints when dry. Creosote oil is generally considered as the best preservative agent. In using this treatment at Indianapolis some eight or nine years ago it was required that the blocks should be thoroughly dry and then impregnated with creosote oil weighing 8.8 lbs. per gal., and giving 10 lbs. of oil per cu. ft. of wood. Owing to imperfect treatment, or to improper quality or insufficient quantity of the oil, the first results were not satisfactory. Later on, an Eastern firm used a mixture of 50% creosote and 50% resin, with 20 lbs. per cu. ft. of timber. This was first laid in Boston in 1900, and is still in fair condition. The Brooklyn specifications for the same treatment required that treated blocks should sink in water. They also included an absorption test, which required that blocks dried for 24 hours at 100° F. should not absorb more than 3% of water during 24 hours immersion. The New York specifications as now modified require not more than 75% of creosote or less than 25% of resin, the wood to absorb 20 lbs. per cu. ft. The weight of this mixture is 9.4 lbs. per gal., as compared with the Indianapolis requirement. The timber is dried at 215° to 285° F., the latter being maintained for three hours. A 25-in. vacuum is then created, and while this is maintained the hot creosote (175° to 250°) is admitted. A pressure of 200 lbs. is then applied. Blocks dried at 120° F. for 24 hours must not absorb more than 3½% of water during immersion for 24 hours.

The woods used are mainly long-leaf yellow pine, Norway pine, Georgia pine, Washington fir, Southern black gum and tamarac. The first is the best, but is becoming scarce. Of five cities, four (New York, Brooklyn, Boston and Indianapolis) require 20 lbs. of preservative per cu. ft. of timber; the other (Minneapolis) requires only 16 lbs. In Indianapolis, plain creosote is specified; the others specify a creosote-resin mixture. With heavy oil, Mr. Tillson doubted whether resin is necessary, but further knowledge is needed of both treatment and testing of blocks. As the blocks are for service exposed in the streets, they should be required to meet the specified tests several months after treatment, and not merely when they are freshly treated. The requirement that treated blocks should sink in water was designed as a quick test, but its reliability is now doubted.

Mr. Geo. W. Tillson, of New York City, was elected President; and Mr. A. P. Folwell, of New York, was elected Secretary. The next meeting will be held at Atlantic City, N. J., in October, 1908.

A NEW BLUE-BLACK IRON PAINT AS A PROTECTIVE COVERING.*

By F. J. R. CARULLA,† M. I. & S. Inst.

In the preparation of iron and steel rods for wire-drawing and galvanizing, as also in the preparation of plates for tinning, etc., the iron is kept for a time in a bath of sulphuric or hydrochloric acid to remove the scale. A number of methods have been devised to utilize the resulting solutions, and it is the object of this paper to present the one which appears to be the most valuable where the solution is one of ferrous chloride, $FeCl_2$.

The acids named are not absolutely neutralized by the reaction, so that the solutions are still active and have to be neutralized before they are subjected to any operation for the recovery of the iron and acid in any form. The sulphate "waste pickle" solutions, as they are termed, are killed or neutralized by the addition of scrap, producing a neutral solution from which copperas ($FeSO_4$) is obtained—these solutions being one of the main sources of this material. When hydrochloric acid is employed ferrous chloride is produced, which is not so tractable a salt as the sulphate, owing to its great solubility; and besides, the demand for it is insignificant when compared with that for sulphate.

The chloride liquors are consequently generally dealt with by adding some base which, combining with the chlorine, will precipitate the iron as an oxide. Lime has been employed; and potash and soda have also been suggested and employed as bases for the precipitation of the oxide of iron, but the product obtained with these two has obviously a value much below that of the materials employed.

The idea occurred to Dr. C. F. Wülfing, for some time a resident in the Swansea tinplate district, that ammonia might be employed to effect the precipitation in question, seeing that the value of the ammonium chloride is greater than that of the ammonia employed. The great drawback to such a process naturally is that the volatile nature of ammonia requires special apparatus, which must necessarily be closed to prevent escape of the ammonia. Especially is this the case, as the solution has to be blown for a considerable period in the presence of ammonia, some of which the air carries off; and provision has to be made not to lose this ammonia.

The necessity for this blowing or oxidation arises from the fact that Dr. Wülfing's main object is to obtain a black oxide of iron, which is only produced after long exposure to the air blast. This oxide, which is of a beautiful blue-black color, is insoluble in water, and when passed into the filter-press leaves a clear solution of ammonium chloride, which is evaporated and allowed to crystallize.

The blue-black precipitate is magnetic, showing it to be Fe_3O_4, and has proven a valuable addition to the list of pigments employed in paints for the protection of structural ironwork. Structures that have been painted with this blue-black oxide (boiled linseed oil being used as a vehicle) have kept fresh though exposed to the weather for nearly two years, still showing a varnish-like surface.

The Sharon Chemical Co., Limited, to whom Dr. Wülfing has assigned the English patent, are putting up a plant in Derby for carrying out the process herein described.

COMPARATIVE TESTS are to be made by the United States Navy upon three fast "scout" cruisers—one equipped with reciprocating engines, one with Parsons turbines and one with Curtis turbines. In the order mentioned, the vessels are the "Birmingham" and the "Chester," being built by the Fore River Shipbuilding Co: and the "Salem," being built by the Bath (Me.) Iron Works. The three vessels are of the same model, and have similar boiler outfits, each rated at 16,000 HP.

*Abstract of a paper presented at the 1907 fall meeting of the Iron and Steel Institute, at Vienna, Sept. 28.

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SEWERAGE SYSTEM AND SEWAGE DISPOSAL WORKS AT KEW BEACH, TORONTO, CANADA.*

By C. H. RUST,† M. Am. Soc. C. E.

That portion of the city of Toronto known as Kew Beach is situated at the western limit, on the shore of Lake Ontario, and is solely a residential district. The level of the ground is only a few feet above the level of the lake and the soil sandy, underlaid with clay. The property owners have been for some time asking for sewerage facilities, but owing to the municipality of East Toronto procuring its water supply from a point about ¾-mile east of this district, and to the objection of the Board of Health to allow crude sewage to be deposited in the lake, it was necessary to adopt the sewers and purification works as described. The drainage area of this district is 185 acres, containing a population of approximately 10,000 during the summer months. To ascertain the consumption of water, a meter was placed upon this district, and it was found that the actual consumption per capita per 24 hours was 10 [Imp.?] gals.

SEWERS.—The main sewer is laid along the lake front at a depth varying from 2 ft. to 9 ft. below the lake level, and is constructed of 16-in. and 10-in. cast-iron socket pipes. All sewers from the north discharge into this sewer and at a point midway between the outfall and the summit is constructed pumping station No. 1. This raises the sewage from the low level sewers from the east and north into the high level sewer which gravitates to No. 2 pumping station, where the sewage is raised into the disposal works. These pumping stations are of concrete, and are circular in plan, with a partition wall in the center. There is at each a reservoir of 3,200 gals., and each contains a duplicate set of pumps and motors; No. 1 has two 5-HP. alternating vertical motors and two 4-in. submerged centrifugal pumps; No. 2 has two 7½-HP. alternating vertical motors and two 4-in. submerged centrifugal pumps. Motors and pumps are automatically controlled by the rise and fall of the sewage in the reservoir. The shafts of the pumps are connected directly onto the armatures of the motors, without any bevel gearing; this practically eliminates all noise whilst operating.

DISPOSAL WORKS.—These works consist of three septic tanks and 12 bacteria [contact] beds, constructed from plans designed by the Cameron Septic Tank Co., and operated by the gear patented by it. The works are erected on the shore of the lake, about 200 ft. from the water, and are supported by 10-in. piles driven 16 ft. through the sand and into the hard clay, and surrounded by tongued and grooved sheet piling driven 14 ft. The work is of concrete in the proportion of 7 parts broken stone and sand to 1 of cement.

The three septic tanks are each 100 × 14 ft., and 7 ft. 3 ins. deep at the low end, with a total capacity of 183,750 [Imp.?] gals. They are covered with a 3-in. concrete roof, made in the proportions of 4½ of broken stone and sand to 1 of cement, and reinforced with No. 10 expanded metal of 3-in. mesh. Concrete beams, 9 × 6 ins., 6½ ft. c. to c., support the roof. These are reinforced with ¾-in. Johnson corrugated steel bars. An inlet channel feeds the three tanks at the high end, each one of which can be operated independently from this channel. The distribution of sewage into the tanks takes place through an 8-in. pipe, thence through four 12-in. openings, 3 ft. above the bottom of the tank. This ensures a maximum flow of sewage with a minimum amount of disturbance. At the low end of the tanks 13 outlet pipes, 4 ins. diameter, are built into the wall, 31 ins. below the water line, connecting with the cleansing chamber and outlet channel. From here the main effluent carrier is built into the wall of the bacteria beds in line with the outlet channel of the septic tanks. This runs the whole length to the end of the beds, and has three branches at regular intervals, each feeding one set of four beds.

The 12 beds are in three sets of four each, and have a combined area of 1,860 sq. yds. [nearly 0.4-acre]. Each bed is 50 × 28 ft., and 4½ ft. deep; and is filled 4 ft. deep with furnace slag varying in size from ¼-in. to 1½ ins. On the floor are laid 14 lines of 3-in. weeping tile collectors, discharging into a 9-in. main collector; 6 ins. below the surface of the slag are six lines of 6-in. weeping tile distributors, fed by a 9-in. main distributor. All discharge pipes terminate in one common chamber, from which a 15-in. main filtrate carrier is laid to the lake, the last 30 ft. being supported on piles.

The sewage is raised to a height of 22.5 ft. at pumping station No. 2 into the inlet channel, which is below water line, and extends to a point beyond the inlet of septic tank No. 3. From this inlet channel the sewage is admitted into each tank, required to be operated through the submerged openings.

The alternate filling and emptying of the contact beds is effected automatically by means of the siter-

*Slightly condensed from a paper read before the American Society of Municipal Improvements, Detroit, Mich., October, 1907.

†City Engineer, Toronto, Ont.

nating gear in the following manner: As soon as bed No. 2 is filled, a small quantity of filtered effluent overflows from the discharge well into a float chamber, lifting the float, at the same time opening the admission valve and closing the discharge valve of bed No. 2. When bed No. 2 is filled, this operation is repeated, the flow of tank effluent is diverted into bed No. 3, and the discharge valve of bed No. 1 is opened and its contents allowed to discharge.

The construction involved 12,262 ft. of 9-in. pipe; 1,509 ft. of 12-in.; 1,349 ft. of 15-in.; 2,451 ft. of cast-iron pipe; 32 manholes, and 982 junctions. The average depth of the sewers was 8 ft. 9 ins. A great deal of this was in sand charged with water, involving constant pumping. The costs of the works were as follows:

Sewers and pumping stations	$37,755
Pumping plant	3,185
Disposal works	13,079
Piling, etc.	5,199
Slag, 2,500 cu. yds., at $1.50	3,750
Automatic distributing gear	4,000
Total	$66,888

It was found after the slag had been in the beds some time about 10% of settlement took place. The works have been in operation since April, 1907, and the effluent so far has been very satisfactory.

BACKFILLING TRENCHES.*

By GEO. C. WARREN.†

This is one of the most important and one of the most generally neglected matters which municipal officials and contractors have to meet in connection with street work. The specifications of the West Park Commissioners of Chicago, which are incorporated in permits granted for making excavations in streets to reach underground service pipes, include the following:

All material excavated from any trench under paved roadways must be removed from the boulevard; said trench being refilled with clean cinders, sand, gravel, or crushed stone, placed in layers not exceeding 6 ins. in depth, thoroughly compacted with heavy hand rammers, using the necessary amount of water to complete perfect consolidation of the backfilling.

For general use in many (if not most) cases this seems unnecessarily severe and expensive in the requirement that all excavated material must be removed from the street and replaced with other material. In the case of Chicago boulevards, such a general stipulation may be justified by either: (A) The importance of not littering the boulevards any more than is absolutely necessary, and of maintaining their fine appearance as constantly as possible; or (B) The knowledge (if it is a fact) that the subsoil underlying is of a character which, after once being disturbed, is unsuitable for backfilling of trenches. But this should not be set out as a generally suitable provision for all cities and all classes of subsoil.

It is a difficult matter to draft a specification which will give efficient results and also a basis of payment for the work which will insure the greatest practicable economy to the city and fairness to the contractor. The greatest difficulty arises from the fact that the method of treatment and the cost vary widely with the character of subsoil, which often varies very greatly within the limits of one sewer or water or gas main trench. Often this cannot be foreseen, and it often varies with the weather conditions.

There is a popular notion that trenches should be allowed to settle for a year before paving, and that then it is safe. This is not only a fallacy which breeds carelessness in cases where it is thought no pavement will be laid in a year or more, but it is impracticable to defer paving until a year or more after all mains and house connections are made and equally impracticable to avoid cutting into a pavement for installing and repairing service pipes. The latter can be guarded against by the exercise of reasonable precaution much more than is generally done. I remember an instance where an asphalt pavement was being laid to replace an old cobble pavement. The cobbles and a few inches of the underlying earth necessary to provide the subgrade were removed; the subgrade rolled with steam roller and concrete foundation laid. While the concrete was "setting" there had been a good deal of rain and at one point in the street the concrete settled and developed a hole into which a hoe handle was inserted the full length without finding the bottom of the hole. Investigation and subsequent examination developed a serious hollow several feet deep about 2 ft. below the surface and over 200 ft. long; this was over a sewer which had been laid 25 years before and doubtless backfilled in what is still the quite generally customary way of merely throwing the earth loosely back into the trench. In this case a crust or arch of solid earth had become formed which did not develop the hollow below until the excavation for the new pavement removed a part of this crust and the rains caused the balance of the crust in one spot to fall into the hole.

In another instance no trouble developed in the construction of an asphalt pavement laid on concrete foundation, but three years later a horse's hoof broke through the surface of the pavement. Here examination developed a hole 6 ft. deep (which it took 50 loads of earth to fill) over a sewer trench ten years old. It is very common for a pavement to settle a year or more after laying of the pavement along the line of a sewer trench filled several years before the pavement, where no trouble developed during the rolling and laying of the pavement. It is still more common to find almost insurmountable difficulty while the paving work is in progress from settlement of old trenches. So much for the theory that however carelessly a trench or other fill is made it will settle itself within a year.

On the other hand, where I have had supervision of the backfilling I have never known of a case where trouble has followed from the settlement of sewer or service pipe trenches made immediately before the laying of the pavement, even with very treacherous soil conditions. I would far rather take my chances on the guarantee of a pavement laid immediately after a sewer trench, the filling of which I could control, than five years after the laying of a sewer, the trench of which was filled with the customary carelessness and view only to the least possible cost.

About two years ago I was going over a street in the Middle West, for the paving of which bids were about to be received. A sewer, the trench of which was from 15 to 20 ft. deep to a clay soil, was being built, using an excavating machine which backfilled without tamping. On account of the looseness of the fill the level of the roadway over the trench was being raised about 18 ins., sloping to nothing near the edge of the road. The specifications clearly provided for "thorough tamping of the trench in courses of not more than 6 ins." On calling the inspector's attention to the provision, he first claimed that it only referred to paved streets. I showed that this was not the case and explained that my interest in the matter was as a bidder, and possible contractor, for the pavement to follow, and received the following retort: "You don't suppose the contractor is going to fill the sewer for you." The outlet of the same sewer passed through a paved street which I found was actually being filled by tip carts loaded from the excavation by buckets and hoisting engines and without any tamping whatever. Further inquiry brought the explanation that this provision of the specifications was not generally complied with; that contractors did not figure on doing so; that the price allowed the contractor did not figure on doing so; and that it would be a hardship to force him to the expense; and that as the pavement would not be laid for a year, the trench would probably be settled by that time. This is only a somewhat aggravated case of what happens to-day, as I believe, in fully three-fourths of the sewer trenches which are being built every year.

In case of permits to public service corporations, plumbers and abutting owners to cut into the streets, whether paved or unpaved (the former is but little more important than the latter), it is only necessary to stipulate as follows in the permit:

The trenches shall be backfilled by such means as the city engineer may direct, depending on the character of the excavated material, in such a manner that all excavated material shall be replaced in the trench without raising the grade of the roadway. Flushing will only be permitted in cases where the subsoil is sand or gravel, or other material from which the surplus water will readily drain away.

In criticism of this proposed requirement, reference may be made to the volume of the pipe. My reply is that except in trunk sewers (to which the permits do not apply) the volume of the pipe is so little in comparison to the volume of the trench as to be insignificant. It is well known that, in ordinary cases, more earth can be tamped into a trench than is removed from it. In my judgment the only case where the rule of "get back all the dirt" cannot apply is in rock excavation, in which case the breaking up of the rock nearly doubles its volume and the particles of rock are so large that they cannot be replaced to their original density.

In the case of contract work for sewers, etc., the case is more difficult, in view of the uncertainty of conditions to be met underground, and the consequent uncertainty of the most economical way to properly backfill the trench. This makes it impracticable for the contractor to figure accurately in advance what the cost "per lin. ft." will be. On this account some contractors are sure to bid far too low to permit proper work, and others figure "safe." In one case the city has the almost impossible task of forcing the contractor to do proper work when the price is too low to permit it without loss. In the other case the probability is that the city will pay too much for the work. An effort should be made to avoid both evils.

My suggestion is to divide prices in such a way that whatever material is encountered a fair price will be allowed the contractor, and also to include certain provisions in the specifications, as follows:

(a) Setting pipes per lin. ft.
(b) Earth excavation per cu yd.
(c) Rock excavation per cu. yd. (if rock is likely to be encountered).
(d) Hauling excavated material to spoil bank (if it is unsuitable for backfilling and its removal is directed by the engineer), per cu. yd.
(e) Lumber delivered on work (if any required for shoring), per M. B. M.
(f) Placing or replacing lumber (if it is reused) in sewer trench, per M. B. M.
(g) Refilling trench, if backfilled by flushing earth excavated from trench, per cu. yd.
(h) Refilling trench, if backfilled by tamping earth excavated from trench, per cu. yd.
(i) Refilling trench, if backfilled by flushing suitable borrowed material (to replace unsuitable excavated material drawn to spoil bank by order of the engineer), including furnishing the materials, per cu. yd., measured in the wagons as material is delivered.
(j) Refilling trench, if backfilled by tamping suitable borrowed material (conditions the same as item "i"), per cu. yd.
(k) Refilling trench with rock excavated from the trench, per cu. yd.

1. Material excavated from the trench which, in the opinion of the engineer, is unsuitable for backfilling shall be hauled by the contractor to a spoil bank and shall be paid for at the price bid per cu. yd. for "hauling excavation to spoil bank." Measurement to be made in the wagons at point where loaded.
2. Flushing in backfilling will be permitted only in case the material is sand or gravel or other material, from which in the opinion of the engineer the surplus water will readily drain away and leave the filled earth solid.
3. Except where flushing is directed by the engineer the backfilling shall be done by thorough hand tamping in layers not exceeding 6 ins. in depth.
4. Whether backfilling of earth is done by flushing or tamping, the full amount of material excavated from the trench, less the volume of the sewer, shall be refilled into the trench without raising the grade.
5. In case rock is excavated from the trench, it shall be backfilled by carefully hand placing the excavated rock in layers with succeeding layers of earth well flushed into the voids between the pieces of hand-placed rock.
6. In case the excavated material is clay, which, in the opinion of the engineer, is too wet to enable solid backfilling by tamping, the excavated wet clay and reasonably dry borrowed earth shall be tamped into the trench in succeeding layers, using enough of the dry earth to overcome the excess of water in the clay and to provide a solidly filled trench to the satisfaction of the engineer. The borrowed earth including tamping to be paid for per cu. yd. of "borrowed material" tamped into the trench. Measurement to be made in the wagons as delivered on the work.

This suggestion may be criticised as being complicated. The conditions are necessarily complicated by practical inability to tell in advance the condition of material to be excavated, and consequently the treatment it should receive in backfilling and the simple but incomplete specifications and method of payment generally adopted in the past has resulted in quite general unsatisfactory results. Some condition should be provided which will correct the evil of poorly filled trenches, however complicated they may be.

Of course, it must be expected that the cost of efficient and proper backfilling of trenches will be much greater than the cost of the inefficient system at present generally in vogue, but the increased cost will be small in comparison to the saving in repairs to road surfaces and vehicles.

An important point not referred to above in connection with repaving over sewer trenches in unpaved streets is the matter of foundation. Even with the greatest care in backfilling the trench, it should be reinforced at the top by a solid Portland cement concrete foundation to the pavement, and the concrete should extend over the edges of the trench about 6 ins. on each side.

It has been suggested that tamping the earth in backfilling trenches be done with pneumatic or steam rammers. This offers suggestive food for the mechanical inventor, but as far as I am aware nothing of the kind has yet been perfected. For the present tamping must be done by hand, and a good rule is two good men with heavy rammers in the trench to each shoveler outside; and put the two best men on as tampers. The common practice where there is even a pretense of tamping is four to six shovelers to one tamper, with the poorest man in the trench, because his work does not count in the amount of trench backfilled.

MACHINE-MINED BITUMINOUS COAL in the United States reached a total of 118,847,500 tons for 1906. For 1905 the total tonnage mined by machines was 103,396,500, and for 1904 but 78,607,000. The percentage of increase in the production of machine-mined coal in 1905 over 1904 was greater than the percentage of increase in the total production; and in 1906 the quantity of machine-mined coal was 15,451,100 tons greater than in 1905, while the corresponding increase in the total bituminous coal production was 21,534,600 tons—72% of the total increase in 1906 over 1905 thus being in the machine-mined product. There were 10,212 machines in use in 1906; of these 5,911, or 58%, were of the pick or puncher type; 4,144, or 40.5%, were chain-breast machines, and 157 were long wall machines. Pennsylvania alone used 45% of the total number of machines, and produced 45.6% of the entire machine-mined product in 1906.

The ratio of the machine-mined tonnage to the total production, in the states in which machines are used, has increased steadily each year: In 1899 it was 23%; in 1900, 25.15%; in 1901, 25.68%; in 1902, 27.09%; in 1903, 28.18%; in 1904, 28.78%; in 1905, 33.60%, and in 1906, 35.1%. The foregoing figures were compiled by the U. S. Geological Survey.

*Abstract of a paper read at the annual meeting of the American Society of Municipal Improvements, at Detroit, Mich., Oct. 1 to 3.

†President, Warren Brothers Co., Boston, Mass.

THE QUEBEC BRIDGE WRECK.

[With folding plate.]

The universal interest of the engineering profession in the fall of the Quebec Bridge on Aug. 29 concerns itself to no small degree with the effects wrought upon the members of the great structure. There has been quite a pilgrimage of engineers to the site of the wreck at Cap Rouge ever since the accident, to study the behavior of bridge-steel and bridge-members under the vast destructive forces generated in the fall.

We are sure that every engineer who has visited the wreck has felt himself well repaid; but of course comparatively few are in position to make this trip. We have therefore thought it worth while to present to our readers a series of large scale half-tone views showing this huge heap of wrecked steel-work from one end to the other. These views are printed on a large folding plate accompanying this issue.

Referring to this plate, the two upper rows of views give a complete representation of the two sides of the fallen anchor arm. Of the 730 ft. of steel-work which projected out over the river, only a few pieces near the pier are now visible above the water, as the right-hand view of the second row illustrates. Thus the 500-ft. anchor arm constitutes practically the whole of the visible wreckage. Our views show this mass from main pier to anchor pier.

A striking features of the two series of side views is the difference in the position of the bottom-chord members on the two sides. On the west or left side of the wreck, the entire bottom chord is in plain view. Our upper row of views shows it clearly for its full length, from the anchor-end section, standing almost vertically at the right, to the partly-buried and split section A 8 L lying adjacent to the main pier, where the foot of the main post or tower appears. Only sections 9 and 10 cannot be seen; these are behind the others, 10 being approximately behind 8, and 9 being curled up behind the panel-point shown in the left-hand part of the second view.

But the east side of the wreck, shown in the second row of views, exhibits a totally different appearance. Posts, eye-bars and laterals occupy the foreground, concealing the bottom chords everywhere except at the anchor end and close to the main pier. At the anchor end (see view at left of second row) the bottom-chord section A 1 R is in plain sight, standing vertically like the corresponding member of the left truss, but in addition buckled badly out of shape, as if by the impact of its forward end on the ground. In the right corner of this same view a broken piece of A 2 can be seen. But thence to the main pier the bottom chords are buried deep by other wreckage. Near the main pier the chords lie closer to the outside. One of the views in the bottom row, the second from the right-hand end, illustrates this.

This difference appears to be due to a slight shift of the whole structure eastward in falling. The lower chords lie on the ground nearly in the respective vertical planes of their trusses; but the upper portion of the superstructure swerved slightly eastward. One of the general views of the wreck in the lower row, looking north along the top of the wreckage, brings this fact well before the eye. In this view the coping of the main pier can be seen at either side of the metal-work, but the superstructure evidently lies some ten or a dozen feet to the right of its original line.

While this circumstance makes the general aspect of the two sides of the anchor-arm very different, it has probably little significance as bearing on the manner of failure. The bridge fell from a great height. Its roadway was not much less than 150 ft. above the surface of the ground on which it fell, and the mean height of the top chord was some 150 ft. more. Yet substantially the whole anchor-arm wreckage may be circumscribed by lines connecting the ends of the main pier and the anchor pier. Considering the great height of fall, therefore, the lateral divergence of the wrecked anchor-arm is extremely small.

The cantilever-arm, of course, cannot be so precisely located; but we have heard that soundings show its outer end to lie east of the line of the bridge, perhaps 50 ft. or more. If this should prove to be correct, both cantilever-arm and anchor-arm have moved somewhat to the right. The two motions are doubtless independent phenomena. Taken in combination, they would tend to show perhaps that the left truss failed a trifle more slowly than the right.

The damage done to the bridge members by the fall was influenced by the condition of the ground below. While this was originally flat, a series of pits had been dug under the anchor span for the foundations of the falsework on which the anchor-arm was erected. These pits, one at each panel-point, happened to be so situated that the posts of the trusses fell directly into them; the anchor leg of the bridge, about 100 ft. high, tilted forward around its base as the bridge fell, and thus carried the structure almost exactly two panel lengths forward, bringing each main post over the pit which lay under the next main post riverward. As the bottom-chord sections fell upon the raised ground between the pits, the vertical impact of the posts at their ends broke off these huge chords like pipe-stems. The posts themselves carrying the weight of the massive top chord anchor chain and the upper lateral system were buckled and torn almost beyond recognition by the terrific impact as they struck the bottom of these foundation pits.

The three detail views at the lower right-hand corner show the two interesting buck'ed chords, A 9 L and A 9 R. We described the known circumstances in connection with member A 9 L in our issue of Sept. 5, and the developments since then have left this description without any important change. The immediately opposite chord section, A 9 R, is also buckled, as has since been found, though it gave no advance warning by a large deflection as did A 9 L. The two views of A 9 R which we show will be examined with much interest, we are sure. The first of these is a view looking west at a group of chords of the right-hand truss about 50 ft. south of the main pier; the north end of A 9 R is in clear view here, apparently uninjured. The second view is taken inside of the wreckage, looking north, in a line parallel to the chords, one of these chords being in sight at the right of the view in fact. The buckled southerly portion of A 9 R appears, sticking up from the ground in a westerly direction. The four ribs of the chord are separated and splayed apart here, just as is the case with the south end of A 9 L.

In explanation of the marks which are to be seen upon the members, we may state that the contractor's forces began, almost immediately after the collapse, to mark afresh on all the main pieces their designating shop-marks in conspicuous places. Many of the old shop-marks had become faint or obliterated, and many could not be seen from outside the wreck. The new marks are those which show most prominently in our photographs. Where a member was badly distorted, so that its shape and position would not be clear from the mere identification by the mark, the names of the visible parts were also painted on, and the direction in which a specified end of the member lay. Thus in the first of the three detail views at the bottom of our plate, the chord member bears the legend "A 9 L West Rib ← North," and in the background of the views there appears (on another portion of the same member) the mark "A 9 L West Center Rib → South."

The meaning of the designating marks will in part be evident, and in part was explained in our issue of Sept. 5, Fig. 3, p. 258. The prefix "A" denotes Anchor-Arm, while "C" denotes Cantilever-arm. An exception is the short section of the cantilever-arm bottom chord, adjacent to the main post ("Center Post"), which, being really part of the tower-base detail and connected to a similar section of the foot of the anchor-arm chord by riveting, was denominated "A 11," the anchor-arm being ten panels (five panels in the main truss-system). The number in the designation of a member is that of the panel, counting northward from the anchor-pier. The terminal letter "L" or "R" denotes left (west) or right (east) truss. The top-chord eye-bars instead of being given panel numbers, were marked "A A" in the third panel, where the top-chord tension is carried up by the diagonals of the first main panel, then "A B," "A C," etc., "A H" being the panel reaching the center post. The various posts were designated differently at main panel-points and intermediate panel-points. The former were counted successively by the number of main posts from the anchorage. Thus, the post between the sixth and seventh 50-ft. panels was called "A P 3," anchor-arm post 3. The intermediate posts were also counted consecutively, and their number indicated by a sequence of zeros. Thus, the vertical between panels 7 and 8 was marked "AT0000." When such a member was made in several sections, the letters "L," "M" or "U" were placed directly after the initial "A." This general system of marking can be followed through in the photographs; S P for sub-post, S V for sub-vertical, T for diagonal tie, etc., entering as variations.

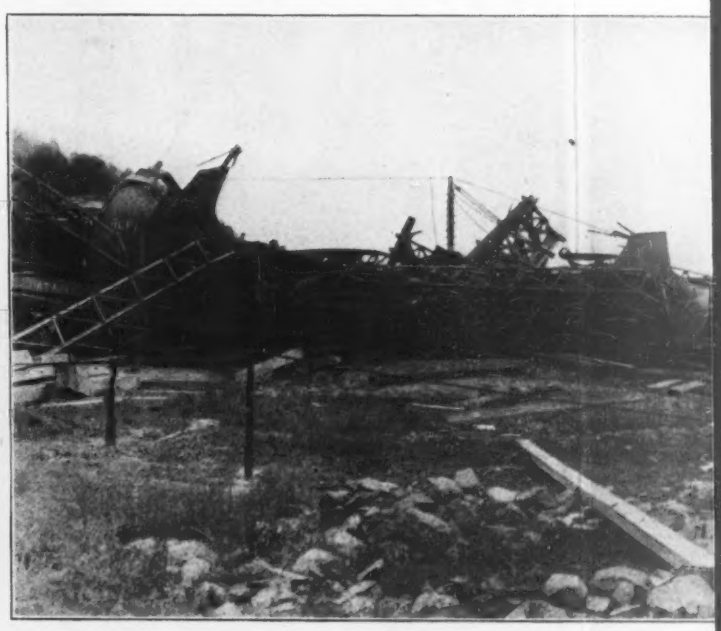
It is a remarkable illustration of the complete destruction wrought by the fall that although the new marking was done by several of the inspectors, who had been on the work for at least two years and were thoroughly familiar with the appearance and details of every member, yet in a number of cases these men found it necessary to refer to the shop-drawings for specific minor details, by which to identify the members. The destruction and distortion had been so thorough that the general characteristics differentiating a member had disappeared, and in order to identify some of the members it was necessary to study such minor features as rivet-spacing and thickness of plates.

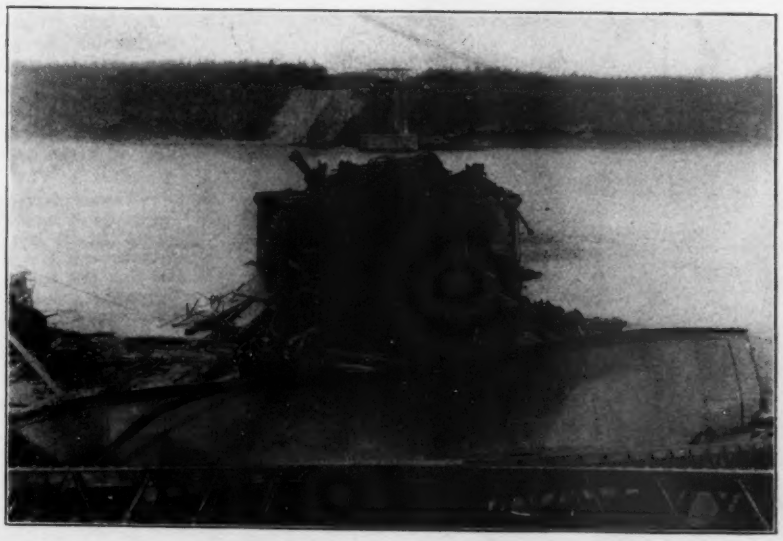
WHAT MAY PROVE A DIAMOND MINE is now under development in Arkansas. The first diamond was found, last fall, near Murfreesboro; two more were found, shortly thereafter, and examined by Dr. G. F. Kunz, the well-known gem expert, formerly connected with the U. S. Geological Survey. Dr. Kunz visited the locality and examined it, and reported favorably. Dr. Henry S. Washington, of the U. S. Geological Survey, then visited the locality with Dr. Kunz and advised a thorough prospecting of the district. A company was formed, which now holds 600 acres in Pike County; within that tract, in an area of 30 acres, upwards of 130 diamonds have since been found, weighing from 1-64 carat to 6¼ carats, and ranging in color from dark brown to the extremely valuable blue-white. One of the largest two found, weighing over 6 carats, Dr. Kunz states to be a stone of the finest blue-white quality.

Dr. Kunz says that while the proposition can hardly as yet be styled a diamond mine, he regards the discovery as one of the most remarkable mineral discoveries in this country; for the diamonds found are the only ones ever found on the North American Continent in the original matrix. Diamonds have been found before, in Wisconsin, Michigan, Ohio, and Indiana; but tracing of them (by Dr. Kunz) has proved them to have been carried there in glacial drift, from sources north of the Great Lakes. Other stones, found in California, Montana, Idaho, and Virginia, were all found to have "floated" there from other sources.

In the Arkansas district the country-rock is sandstone of coarse grain, cut by peridotite dikes. [Peridotite is a rock somewhat like the "blue ground" of the South African diamond district.] Dr. Washington will make, in conjunction with Dr. Kunz, a full report on the district, which will shortly be published by the Survey. A paper on "The Occurrence of Diamonds in the United States," by Dr. Kunz, will appear in conjunction with the report.

THE WORLD'S COAL PRODUCTION for 1903 was about 1,106,478,700 short tons. Of this amount the United States produced 414,157,300 tons, or 37.5%. In 1868 this country's percentage of the world's output was only 14%; it is only eight years since the United States supplanted Great Britain as the leading coal producer. In 1903 the United States produced 43.7% more than Great Britain, and 83% more than Germany; excluding Great Britain, this country produced more coal in 1906 than all other countries combined. Detailed statistics on the subject will be found in an advance chapter of "Mineral Resources of the United States" for 1903, by E. W. Parker, Chief Statistician of the U. S. Geological Survey, which will soon be ready for distribution.



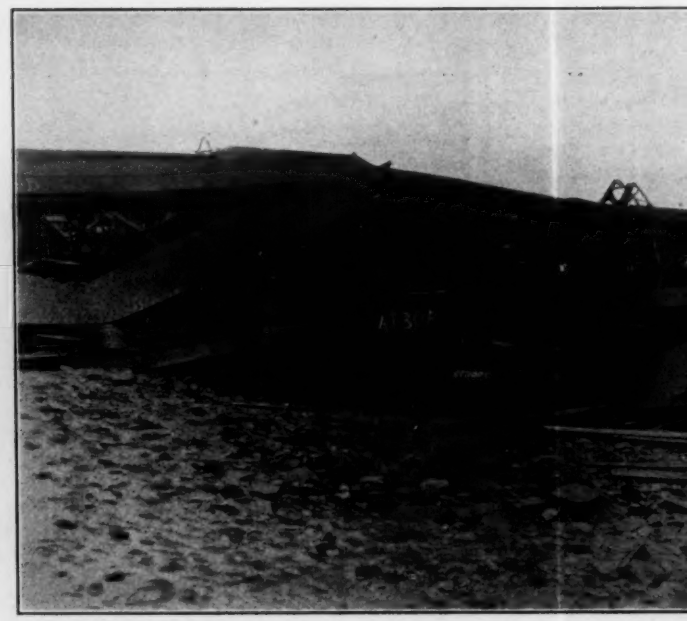


LOOKING NORTH FROM ANCHOR PIER.

ANOTHER VIEW LOOKING NORTH.

Main Pier at Left.

A CONTINUOUS SERIES OF VIEWS ALONG THE W



Anchor Pier to the Left.

A CONTINUOUS SERIES OF VIEWS ALONG THE

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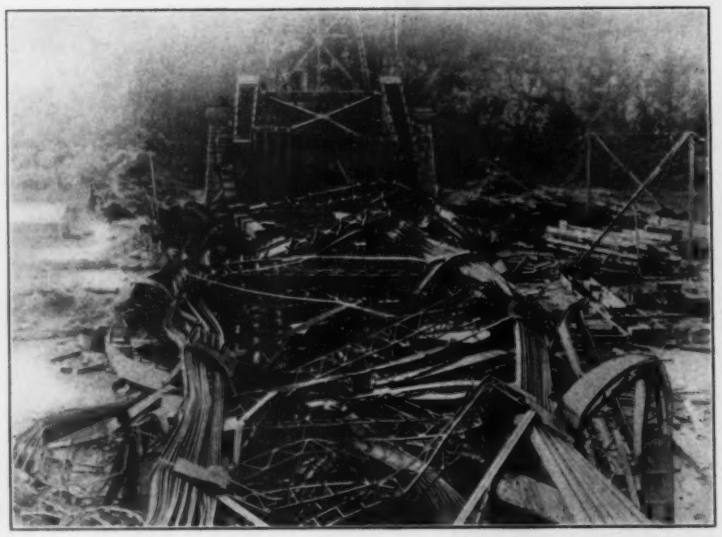

LOOKING SOUTH FROM MAIN PIER.

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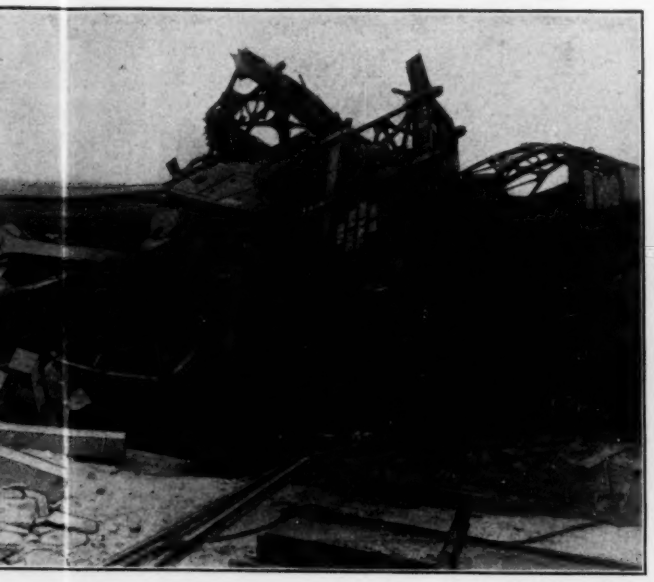
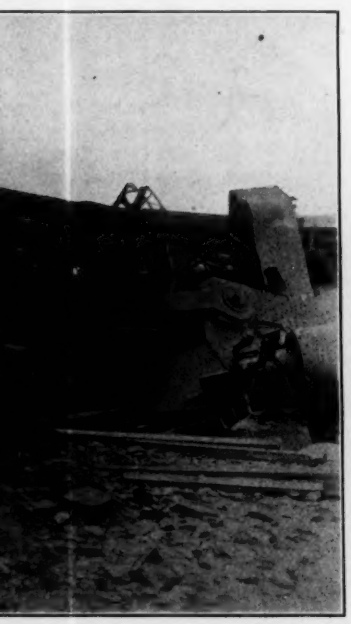
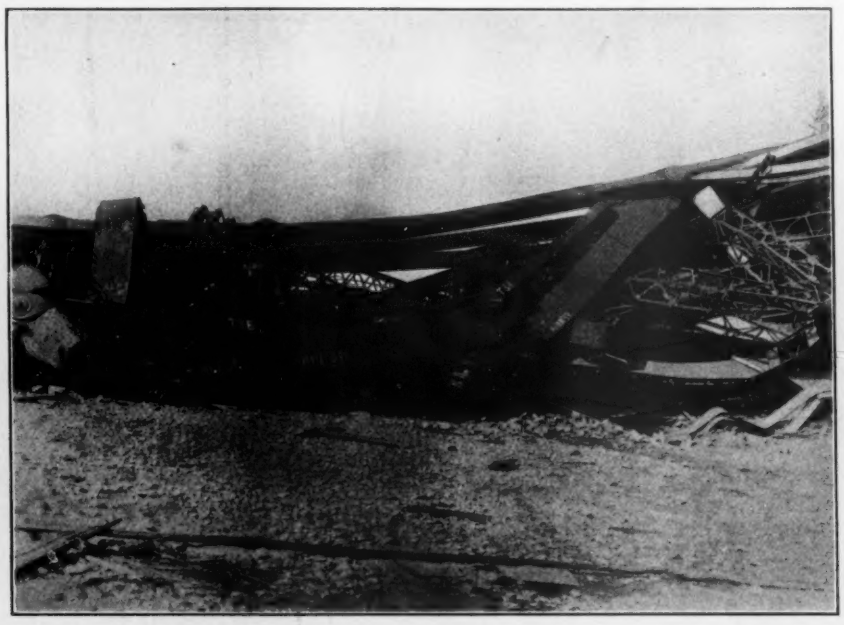


NG THE WEST SIDE OF THE WRECK.

Anchor Pier at Right.





ALONG THE EAST SIDE OF THE WRECK.

Main Pier at Right.

EC BRIDGE FAILURE.

OF THE WRECKAGE
OF THE
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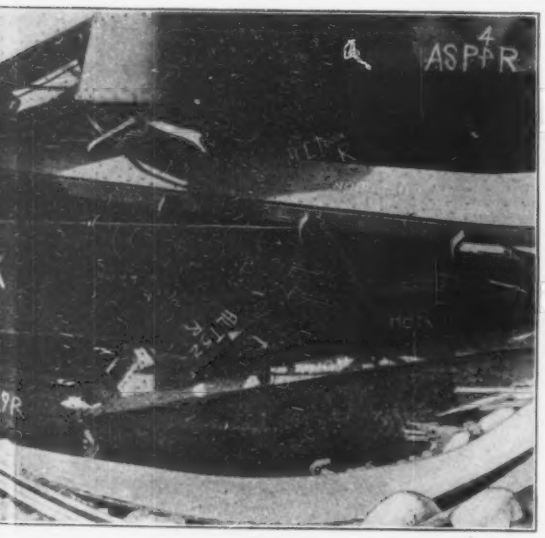
Taken During the Week Following the
llapse of Aug. 29, 1907.

DETAIL VIEWS OF THE TWO



S OF THE TWO BUCKLED BOTTOM-CHORD SECTIONS.

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One of the striking contrasts between the civilized man and the savage is that the former makes provision for the future, while the typical savage lives from hand to mouth. It is the mark of the highest civilization to foresee the needs, not only of the immediate future, but of distant times; not only of the generation now living, but of generations yet unborn.

A problem which has been pressing closer and closer upon public attention for the past quarter century is the rapid exhaustion of natural resources. Half a dozen years ago* we called attention in these columns to the prodigal use and waste of Nature's gifts and the necessity of prompt action to economize in their consumption, and particularly to stay their wanton destruction if the world is to be saved from a fast-approaching famine in some of these necessities. Since that time the subject has attracted more and more the attention of thinking men. We may mention here particularly the late Prof. N. S. Shaler's notable book on this subject.

Now, however, it is brought into world-wide prominence by the address of President Roosevelt at Memphis last week. As many of our readers may not have access to newspapers containing that address, we take space here for the following excerpt:

> Many of these resources which we have been in the habit of calling inexhaustible are being rapidly exhausted, or in certain regions have actually disappeared. Coal mines, oil and gas fields and iron mines in important numbers are already worked out. The coal and oil measures which remain are passing rapidly, or have actually passed, into the possession of great corporations, who acquire ominous power through an unchecked control of these prime necessities of modern life—a control without supervision of any kind. We are consuming our forests three times faster than they are being reproduced. Some of the richest timber lands of this continent have already been destroyed and not replaced, and other vast areas are on the verge of destruction. Yet forests, unlike mines, can be so handled as to yield the best results of use without exhaustion, just like grain fields.
>
> Our public lands, whose highest use is to supply homes for our people, have been and are still being taken in great quantities by large private owners, to whom home making is at the very best but a secondary motive subordinate to the desire for profit. To allow the public lands to be worked by the tenants of rich men for the profit of the landlords, instead of by freeholders for the livelihood of their wives and children, is little less than a crime against our people and our institutions. It is clear beyond peradventure that our natural resources have been and are still being abused, that continued abuse will destroy them, and that we have at last reached the forks of the road. We are face to face with the great fact that the whole future of the nation is directly at stake in the momentous decision which is forced upon us. Shall we continue the waste and destruction of our natural resources, or shall we conserve them? There is no other question of equal gravity now before the nation.
>
> It is the plain duty of those of us who for the moment are responsible, to make inventory of the natural resources which have been handed down to us, to forecast as well as we may the needs of the future, and so to handle the great resources of our prosperity as not to destroy in advance all hope for the prosperity of our descendants.
>
> As I have said elsewhere, the conservation of natural resources is the fundamental problem. Unless we solve that problem it will avail us little to solve all others. As a preliminary step the Inland Waterways Commission has decided, with my full approval, to call a conference on the conservation of natural resources, including, of course, the streams, to meet in Washington during the coming winter. This conference ought to be among the most important gatherings in our history, for none have had a more vital question to consider.

*Engineering News, Jan. 31, 1901.

An African plate-girder bridge, illustrated on another page, contains two peculiarities of construction that strike an American designer as worth attention. These are the inclined stiffeners in the end panels, and the midspan field-splicing of the main girders. The latter arrangement can only be a matter of surprise, in the absence of a statement why the splice was put at the point of greatest moment. It is evident, of course, that if the maximum weight and length of shipping-piece correspond approximately to those of a half section of the girder, a splice at the center seems the simplest. But the unavoidable awkwardness of a flange-splice in a plate-girder usually results in a preference for splicing at a point as far removed from the maximum section as possible. In continuous-girder construction it is possible to make the division at the points of average zero moment, and then it is permissible (and in fact highly advantageous) to substitute a hinge for the splice, thus converting the continuous into a cantilever arrangement. Such an expedient is not applicable to simple spans, and, when the girder can not be shipped in one piece, a splice designed to take definite bending moments must be used. A splice near the end requires smaller splice-pieces and fewer rivets than one at the center, so that frequently the two splices may be cheaper than the single splice at the middle; the theoretical greater weight and strength of the web-splice in the former case has no considerable effect on this relation. The important consideration is that since a riveted splice, of necessity, has less strength than the members spliced, it forms the weak point of the flanges when placed at the center, and the flange-section must be increased to make up for the reduction in efficiency. At other points than the center, excess of flange section is usually present, and if not it can easily be provided. Altogether, the central splice is rightly out of favor in this country, and its use by the German builders in the present case represents unusual practice.

The inclined end stiffeners, on the contrary, are recognized as very desirable. They have been often enough recommended on theoretical grounds, but in America, at least, practice has taken them up only in exceptional cases if at all. It is a fact that they decrease the maximum web-shear and simplify the stress conditions in the most troublesome part of a plate-girder. On the other hand, they involve a few bevel cuts of angles and fillers, and in most cases to be really effective they need gusset-plates at the base, both of which conditions complicate the construction. There does not appear to be strong reason against them, however, and we must look upon them as a desirable feature in plate-girder construction.

The building of a 2-ft. gage railway 360 miles long in German East Africa, described in this issue, raises in the minds of an American engineer the question whether such a construction can be defended. In the United States, of course, the narrow gage fallacy has had its day; and the matter of break-of-gage alone has compelled the abandonment of narrow gage construction in almost every part of the continent.

Abroad, however, and particularly in the newer countries of the world, the idea that a narrow gage railway is the proper thing for light traffic has still a strong hold. This remarkable 2-ft. gage railway in East Africa is a forcible illustration of the extremes to which the narrow gage idea is sometimes carried.

As we have frequently pointed out in these columns, the best and most effective answer to the claim that a narrow gage railway for light traffic can be built more cheaply than a standard gage road is to cite the actual work done in this country in building cheap lines of railway, such as those used for lumbering or logging. No railways of any gage anywhere in the world are built at a lower cost per mile than are railways of this class in the United States. Of course, the builder of a lumber railway here is very apt to use second-hand rails and rolling stock; and he can cut his ties alongside the line for the mere cost of labor. Moreover, most lumber roads are built in fairly level country where grading is not a large item. To that extent the conditions are dissimilar to those confronting the builder of a pioneer railway in a desert region such as that penetrated by the Otavi line.

As has been often emphasized, a narrow gage railway is cheap to construct not so much because it is narrow gage, but because it has very light rolling stock. If you will use equally light rolling stock, you can build a standard gage line almost as cheaply. We say *almost* as cheaply, because the narrow gage road does have a very small advantage in the width of embankments and cuttings; and it can use considerably shorter and cheaper ties. On the Otavi Ry. the track was of the "portable" type, with steel ties secured directly to the rails and laid with them in complete sections. This makes, of course, a very easily and rapidly laid track. The curves appear to have been "made in Germany," and a standard curve of 500 ft. radius (11½°) was made to do duty almost everywhere, indicating that the line was laid across a plain, for the most part. Of course this curvature, as well as the sharper curve of 22°, used semi-occasionally, was well within the capabilities of standard gage railways. The grades were extremely easy for a line of this sort, the maximum being not over 2%.

Taking into consideration the small size of the ties and the advantage of laying ties and rails together, it is probable that the 2-ft. gage line was built considerably cheaper than the lowest figure at which a standard gage line could have been constructed. When it comes to operation, however, we feel confident that the standard gage line would save enough in expenses to pay a very large return on the difference in cost. A 2-ft. gage track must be maintained in pretty good condition or the locomotives and cars have an inconvenient habit of turning over and rolling down a bank. Indeed such things have happened on 3-ft. gage lines.

The designer of a 2-ft. gage locomotive has his hands full puzzling how to find room for necessary parts. It is difficult to find room to make an economical fire-box or an efficient boiler. On the other hand, it is very easy to make a standard gage locomotive of light weight and small power which will have excellent efficiency.

We believe, therefore, that a standard gage road can be built which will cost less per mile to maintain and which will require less fuel per ton-mile of train hauled. In addition, the standard gage road can handle without difficulty articles too bulky to be moved on the narrow gage; it can convey passengers with greater comfort, safety and speed, and can therefore secure larger revenue from this source.

Taking all these things into consideration it is difficult to see any sound reason for adopting the narrow gage system even for the construction of remote and isolated lines.

It may be worth while to refer here to the old idea that the narrow-gage system was worth while on roads with sharp curvature because of the smaller curve resistance on the narrow-gage line. There is just enough of truth in this old fallacy to make it tenacious of life, and we presume many engineers to-day are still under the impression that for mountain roads with sharp curvature, such as the Denver & Rio Grande, the narrow gage system may still be preferable to standard gage.

Twenty years ago, however, the late A. M. Wellington showed that for cars with the same truck wheel-base the curve resistance on a 3-ft. gage road would be only one-sixth (16⅔%) less than on a standard gage road. Against this trifling difference in curve resistance must be set the increased friction on curves and tangents alike due to the smaller diameter wheels, and the practical fact that on sharp curves, where large superelevation is desirable, the margin of stability is much less with the narrow gage.

THE PROPOSED LAKES AND GULF DEEP WATERWAY.

The journey of President Roosevelt down the Mississippi River, and his address before the Deep Waterways Convention, at Memphis, last week, has attracted the attention of the whole nation to the project for a deep waterway between the Great Lakes and the Gulf.

As many of our readers know, this proposed deep waterway has been agitated at intervals for more than half a century. It was kept distinctly in mind when the Chicago Drainage Canal was planned and built, in the early '90's. The project has never been able to command wide support, however, until very recent years, when the enormous growth of traffic, and the inability of the railway lines at times to move all the freight demanding transportation, has turned public attention to the development of internal waterways on a larger scale than has heretofore been attempted.

Last week's convention at Memphis was held for the purpose of arousing public sentiment and influencing Congress toward the creation of this waterway. The convention was attended by the Governors of 16 States and by many Senators and Congressmen. The importance of the action taken is such that we deem it worth while to print the resolutions adopted by the convention at its concluding session, as follows:

Whereas, For more than half a century the desirability of a deep waterway extending from the great lakes of the North to the Gulf of Mexico has been generally recognized and favored by many of the leading statesmen and publicists of America as an economic and commercial, if not a strategic and military necessity; this sentiment being first voiced in part, it will be remembered, by the historic convention composed of delegates from all the Northwestern and Southern States, held in the City of Memphis in November, 1845, with John C. Calhoun as chairman, in the following direct and forceful resolution, to-wit:

Resolved, That the project of connecting the Mississippi River with the lakes of the North and thence with the Atlantic Ocean by a ship canal is a measure worthy of the enlightened consideration of Congress,

And, whereas, The demand for the speedy completion of this magnificent public work has become more and more apparent and pronounced as the country has developed, it being now manifest to the most casual and careless observer that, notwithstanding the enormous increase in railroad mileage during the past fifty years, the transportation facilities furnished thereby are totally inadequate to the task of handling properly, economically and satisfactorily the vast tonnage supplied by the increased output of the mines, farms and factories of the Mississippi Valley; and

Whereas, It is also manifest that the valuable system of waterways provided by nature as a natural rival of the railroads of the country and the ever-present and potent regulators of their transportation charges have been too long neglected, or at least that their development and betterment have not kept pace with the reasonable demands and requirements of the public; and

Whereas, It is known of all men that the completion of the Panama Canal will, in the language of the great American navigator and naval commander, Commodore Maury, "carry the delta of the Mississippi across the continent and place one mouth of that river in the Pacific Ocean—thus making the greatest of rivers tributary to the greatest of oceans"—and it is also known that to reap all the benefits and rich rewards that will follow the completion of the isthmian canal we must provide direct, safe and cheap transportation for natural and manufactured products of the Mississippi Valley by means of a deep waterway of a minimum depth of 14 ft., extending from Lake Michigan to the Mississippi and thence southward via that river to the Gulf of Mexico; and,

Whereas, The National Government is charged by our constitution and laws with, and in pursuance thereof has properly assumed control and jurisdiction of the rivers, harbors and waterways of the country, and is therefore committed to the duty of their improvement by some comprehensive and intelligent plan which will best conserve the interests of the whole people; therefore, be it

1. Resolved, That it is the sense of this convention that the deepening of the waterways from the lakes to the gulf is a public necessity, and that it is a national and imperative duty to take definite and immediate action to deepen said waterways to a depth of 14 ft. from the lakes to the Gulf of Mexico through the route already selected by the army engineers with all practical speed.

2. Resolved, That it is the intention that this grand channel shall be a part of a great, comprehensive system of inland waterways which shall include the great tributaries of the Mississippi River and the other meritorious waterways of the Mississippi Valley.

3. Be it further resolved, That we respectfully ask that said work be constructed according to the continuing contract system.

4. Resolved, That the Lakes-to-the-Gulf-Deep-Waterway Association hereby extend thanks to our colaborers in the great work of inland waterways improvements, the Mississippi Valley Improvements Association, the Upper Mississippi Improvement Association, the Interstate Mississippi River Improvement and Levee Association, the Ohio Valley Improvement Association, the Interstate Inland Waterways Association of Louisiana and Texas, and all other kindred associations in this great valley, for their valuable assistance in the past, and assure them of our sympathetic interest in the object of their efforts in the important work in which they are respectively engaged, and of our most cordial and energetic cooperation therein.

7. Be it further resolved, That Hon. William K. Kavanaugh, President of the Lakes to the Gulf Deep Waterway Association, be and he is hereby requested and empowered to appoint a committee, composed of fifty members, to present these resolutions to the next Congress of the United States, and also to use all honorable and proper means as the representative of and in connection with this association to induce Congress to act favorably thereon at its next session, and that the said president of this association be chairman of said committee.

8. Resolved, That we heartily indorse the efforts of the Rivers and Harbors Congress of the United States to secure an annual appropriation of not less than $50,000,000 for the improvement of rivers and harbors.

That the promoters of the Lakes and Gulf deep waterway are proceeding with some appreciation of the difficulties involved is evident from their demand for no greater depth than 14 ft. for the proposed waterway.

There has been, of course, more or less talk of making the Mississippi River an arm of the sea; but every one who has given even the slightest study to the problem knows that ocean steamers cannot ascend the Mississippi, and that it is not within the power of the forces which man can bring to bear to make that river into a ship channel. Even a depth sufficient for the steamers on the Great Lakes is impracticable.

Even if it were within the scope of engineering and financial feasibility to make a 21-ft. channel from Lake Michigan to New Orleans, it would not be worth while to undertake it. River vessels of moderate draft and comparatively light hull construction can handle traffic over the 1,300 miles of river and canal navigation from Chicago to the Gulf more economically by far than it could be handled by such vessels as now navigate the Lakes. Further, the bulk of the traffic on the Illinois and Mississippi River waterway would not come from the Lakes, but from the country lying west of the Mississippi.

On the assumption, then, that river vessels and not Lake or Ocean vessels are to use the proposed waterway, it can be understood that 14 ft. depth would give probably as economical transportation as any greater depth. The conditions are entirely different from those obtaining in the navigation of open waters, subject to violent storms. Indeed, for the conditions obtaining along the Mississippi, it is quite possible that a smaller depth than 14 ft. would serve commerce equally well.

In studying the problem of economical transportation by internal waterways, the greatest economy should be sought; and since the cost of making and maintaining the waterway is ultimately a part of the cost of transportation, it should be included in comparing waterways of various depths. Such a comparison, it is needless to say, could only be made as a result of careful study of the problem by experts. For a popular convention, such as that held at Memphis, to fix the depth of such a channel may lead to serious error.

At present the government engineers are engaged on a survey of this proposed waterway, and their report may be expected, we presume, when Congress convenes next month. In advance of such a report, it is impossible to discuss the project in detail. We shall only attempt here to give some idea of the difficulties to be encountered.

Mr. L. E. Cooley, who has been among engineers the most prominent advocate of this waterway, divides it into three sections, as follows:

The Illinois—Chicago to St. Louis—with a length of 367 miles and a fall of 196 feet.

The middle Mississippi—St. Louis to Cairo—186 miles long, with a fall of 108 feet.

The lower Mississippi—Cairo to Red Rock—764 miles long, with a fall of 275 feet.

The first section, the improvement of the Illinois River, offers no particular difficulties. It is merely a matter of creating slack-water navigation by a system of locks and dams; and as rock foundations are available for these, the work can be carried out without serious difficulty. We believe the preliminary estimates of the government engineers indicated a total cost of some $30,000,000 for a 14-ft. waterway from the lower end of the Chicago drainage canal, near Joliet, to St. Louis.

But when the problem of a deep waterway down the Mississippi is presented, no such easy solution is possible. No engineer, who looks on the "Father of Waters" in its flood stage, could dream of confining that turbulent flood by any dams ever erected by man. The Mississippi below St. Louis is like a huge rainwater spout, carrying vast volumes of flood water when the rainfall is heavy, but with a flow dwindling to very small proportions in the dry weather of summer and fall. Any forces that man can set at work are puny compared with the size of this great river; and to make matters still more difficult, the river flows through an alluvial plain, with no bottom anywhere to give foundation on which possible works for river control might be founded.

For ten years past the Mississippi River Commission has maintained a minimum depth of about 8½ ft. in the low-water channel from St. Louis to the Gulf by hydraulic dredging on the bars between the pools. At its low-water stage, of course, the river is a succession of pools of good depth, connected by stretches of comparatively rapid and shallow water. By deepening these shallow rapids with hydraulic dredges during the low-water months, lasting usually from September to January, it is possible to afford about 8½ to 9 ft. in depth. This work is, of course, merely temporary, and has to be done over and over again every season, and in fact has to be continued during the whole of the low-water period.

As can be readily understood, this plan of river improvement is of limited scope. Increasing the amount of dredging cannot greatly increase the depth of water; for, as the rapid connecting two pools is deepened, the water in the upper pool is lowered.

It has been suggested that the low-water depth could be increased by turning more water into the Mississippi from the Great Lakes and from reservoirs on the headwaters of the Mississippi in Minnesota. The difficulty with this is the great size of the Mississippi's channel and its rapid fall, particularly in the section from St. Louis to Cairo. It takes an enormous volume

of water to have much effect in increasing the navigable depth. Further, a heavy draft is already being made on Lake Michigan, through the Chicago drainage canal, and to a considerable extent the lakes in Minnesota are actually in use for river regulation. How to get an additional 5 ft. of depth for low-water navigation below St. Louis is therefore an unsolved problem.

Proposals have been made to construct an artificial waterway alongside the Mississippi, following the natural bayous so far as possible. Such a waterway, however, would have all the disadvantages of canal navigation, in the way of restricted speed; and it is more than doubtful whether it would be feasible to construct and maintain it, even with unlimited outlay, in the alluvial soil of the lower Mississippi valley.

It is natural that the residents of the central States should be eager for the improvement of river navigation throughout the Mississippi and its great tributaries; but as President Roosevelt wisely said, in his address at Memphis, no project should be undertaken "until after the most elaborate expert examination and reliable calculation of the proportion between cost and benefit."

We have before referred with highest commendation to the appointment by the President of the Internal Waterway Commission. The nation may well look to that body for some authoritative opinion as to what projects of waterway improvement should be undertaken, and how they should be carried out.

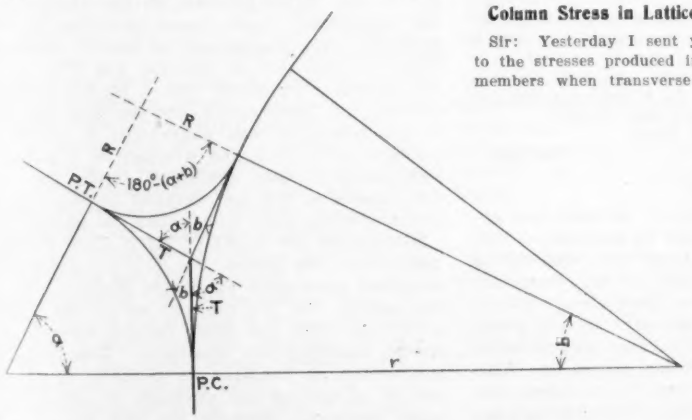
Enough public money has been spent on the old plan of portioning out appropriations between rival Congressmen and rival geographical sections. It is time that a definite policy was adopted for the systematic improvement of waterways, so that effort can be concentrated upon those works that are national in their scope, and that promise the widest increase of public benefit.

LETTERS TO THE EDITOR.

A Railway Curve Problem.

Sir: The following problem in railway curvature, which the writer was obliged to work out some years ago, may be of interest to your readers. The included angles and degrees of curvature being given for two curves which have a common *P. C.*; the problem is to connect the two curves by a third curve tangent with the curve of less radius at its *P. T.*

Find length of radii for both curves, also length of tangent for the curve of lesser radius. The three



curves being tangent, each with two others, must have tangents of equal length and a common *P. I.* Having the angle *a*, solve for the length of tangents *T*. Then, having *T* and the larger radius *r*, solve for the angle *b*. The included angle of the third or connecting curve will be $180° - (a + b)$. Solve *R* from the equation $T = R \tan \frac{I}{2}$. Then proceed in the usual manner.

Yours truly, W. J. Mozart,
Assoc. M. Am. Soc. C. E.

93 Hancock St., Malden Mass., Sept. 20, 1907.

Calcium Chloride as a Waterproofing Solution for Concrete.

Sir: I have read with a great deal of interest in your issue of Sept. 26 the highly scientific, even if somewhat speculative, paper by Mr. Richard H. Gaines on "The Permeability of Concrete and Methods of Waterproofing," as well as your equally interesting editorial on the subject.

A little over a year ago I was led to investigate the present condition of the art of waterproofing through a line of experiments which I had been making in an endeavor to devise a more satisfactory paint for waterproofing purposes than those now in use. I am sorry to say that my efforts were not crowned with success. I became, however, fascinated with the subject itself and made somewhat of a study thereof, the results of which have been condensed into a paper read on the 23d of March last before the "Technischer Verein von Philadelphia" and published in the July number of "The Technologist." My conclusions were to the effect that if the initial set of Portland cement could be retarded and the final set accelerated in such a manner that the formation of alum and calcium crystals could be made to take place almost simultaneously with the formation of the silicates, this ought to lead to the production of a waterproof wall. I went into this subject somewhat more thoroughly regarding chemical and mechanical effects than necessary to repeat here. Suffice it to say that my deduction was in favor of the addition of a 1 to 2% solution of calcium chloride to the water used in mixing the Portland cement. Lately I have been informed by a prominent engineer that he had acted on my suggestion and had obtained excellent results. It would therefore be interesting to know whether Mr. Gaines has made any tests in this direction. It seems to me that the calcium chloride should be what he would consider "a suitable electrolyte" and that the cement itself might be relied upon to furnish "the colloid" out of its own clay. In other words, I am rather inclined to think that the addition of the above small percentage of calcium chloride ought to cover the first as well as the third clause of the summary by which he concludes his very instructive communication.

Yours respectfully,
C. D. Rinald.

1142-46 North Hancock St., Philadelphia, Pa., Sept. 27, 1907.

[We understand that the Board of Water Supply experimented with calcium chloride as the electrolytic reagent in the concrete mixture, with results which, though favorable, did not reach the efficiency of some other electrolytes. However, there are reasons why chlorine salts do not furnish the best mediums for waterproofing. All chlorine salts are either deliquescent or efflorescent, either of which properties is undesirable in a concrete mixture; they also are of such a nature as to produce an optimum condition of corrosion of the reinforcing steel. Where possible it seems to be advisable to use an electrolyte with a higher charge of metallic ions than the chlorine compounds contain; a condition satisfied by the alum salts.—Ed.]

Column Stress in Lattice Diagonals with Cross-Ties.

Sir: Yesterday I sent you a communication relating to the stresses produced in the latticing of compression members when transverse ties are used in addition to a double system of diagonals, by the direct axial compression of the main sections. Today's issue of Engineering News contains an article by Mr. H. S. Prichard and a communication from Mr. John Bartholomew dealing with the same subject, which, it seems to me, render unnecessary the publication of my letter of yesterday. Mr. Prichard treats the question in a more general way than was done in my communication and obtains identically the same results. Mr. Bartholomew's analysis would also lead to the same conclusions, if (using his notation) the *gross* area of the tie angle *B* were substituted for the net area in the equation immediately following his equation (2). This should be done, of course, as the entire question is one of stress corresponding to a given deformation, and the relative deformations of the lattice and tie angles are dependent upon their relative gross areas, irrespective of the character of stress induced. For this reason the equation (2) is only true if the unit stress S_b in the tie is that unit stress which, acting upon a member of a given length and gross cross sectional area *B*, will produce in it a total deformation amounting to 2*b*.

Yours very truly,
Albert B. Hager,
Assoc. Mem. Am. Soc. C. E.

15 William St., New York City, Oct. 3, 1907.

The Quebec Bridge and the Forth Bridge.

Sir: Your carefully prepared remarks on the causes leading up to the collapse of the great Quebec bridge have been closely followed in Canadian engineering circles.

It is perhaps needless to state that the prevailing opinion here is that the whole of the bridge compression members were designed too light.

Another subject of comment is the following, taken from the "Proceedings of the Engineering Society of West Pennsylvania," June 16, 1891, and attributed to Mr. Theodore Cooper:

> You all know about the Firth of Forth bridge, the clumsiest structure ever designed by man, the most awkward piece of engineering in my opinion that was ever constructed, from the American point of view. An American would have taken that bridge with the amount of money that was appropriated and would have turned back 50% to the owners, instead of collecting when the bridge was done, nearly 40% in excess of the estimate.

In view of the fact that the Forth bridge is up and doing business, whereas the great American engineers' Quebec bridge is now an 18,000-ton scrap heap, don't the above remarks form a caustic commentary on any such spread-eagleism as applied to engineering work?

The Forth bridge has been a target for numerous fault-findings on the part of American engineers, but in view of the events of August 29 at Quebec, there will probably now be an ending of such remarks.

The Engineering News deserves hearty congratulations on its fine enterprise in so promptly getting hold of interesting details after the Quebec accident.

Yours truly,
"Canadian."

Montreal, Oct. 2, 1907.

[There is no more common error than the error of drawing broad conclusions from isolated facts. In the study of accidents and failures, and in the endeavor to make their occurrence a guide in future practice, one must constantly be on guard against the tendency to give undue importance to the big events, concerning which everybody is talking and thinking, and to overlook entirely the minor occurrences to which little attention is paid, but which may teach a lesson just as important and deserving of attention as a big disaster costing many lives.

Because the Quebec bridge fell, and the Forth bridge still stands, we cannot safely conclude that the types of bridge construction they represent are respectively bad and good. The old Victoria tubular bridge at Montreal stood till it was taken down; but that fact could not save the type it represented from condemnation by every intelligent structural engineer.

We said last week that American bridge engineers—and we will include in this those north as well as south of the International boundary—still believe in the American system of bridge construction, notwithstanding the collapse at Quebec. The features in the Forth bridge subject to criticism have not been altered a particle by the events of Aug. 29. Unless and until it can be shown that the Quebec collapse was due to the type of construction adopted, and not to deficiencies in details of design, the type of construction the Quebec bridge represents is as deserving as ever of the confidence of engineers.—Ed.]

The Quebec Bridge Chords.

Sir: Your issue of Oct. 3 has been read with interest. The discussion of the Quebec bridge chords in this issue is so complete that the notes sent a week ago would add little thereto except as to general specifications.

Failure of members such as the Quebec chords is not the result of a single defect, but, as the writer looks at it and as your editorial points out, the accumulated effect of many. Thus, the disregard of column length (1) in main shaft and (2) in the sections between lacing points; (3) the effect of local buckling in rendering the distribution of stress over the section unequal (to what extent?); (4) the stress in the lattice-bars due to compression in main section, tending to reduce the efficiency of an already weak detail; (5) the questionable efficiency of the stitch-riveting in the webs unsupported by rigid or sufficiently wide and large flanges; (6) the lack of the torsional stiffness secured in ordinary struts through far greater proportional area of flanges and consequent stiffness against buckling. All of these elements unquestionably played a part, though it would seem that the lacing connections probably slipped first under overstrain, followed by slight buckling of the chord as a whole and local buckling between points of lacing, leading to a new and more unfavorable distribution of stress until the danger point and final collapse occurred.

Whether we may be able to separate each unfavorable

element out and determine its precise weight is open to question. But in the aggregate these elements seem sufficient, now that attention has been called to them, to account for the collapse and restore confidence in the work which may be done under a more complete specification.

C. A. P. Turner.

Minneapolis, Minn., Oct. 6, 1907.

The High Unit-Stresses Used in Designing the Chords of the Quebec Bridge.

Sir: In the discussion of the cause of the Quebec disaster, and the criticism of the design of the compression chords, Mr. Sardullo has sharply criticised the unit stresses considered allowable by the designers of the bridge. Calling the ultimate strength of such columns 35,000 lbs. per sq. in., and using 24,000 lbs. per sq. in., as allowed by the designers, he finds the factor of safety only 1.4. Is it possible that the Quebec Bridge designers permitted unusually high unit stresses, with the factor of safety anything like as low as 1.4? Bridge designers universally attempt to adhere to a factor of at least 4, and considering the practical certainty of imperfect workmanship, and consequent eccentric application of load and initial bending, together with the meager and unsatisfactory nature of the tests of built steel columns, it seems almost criminal to allow anything much less than the factor 4. It would seem, also, that the designers of such a monumental structure, the longest span in the world, should take no chances whatever. Yet the sudden failure during erection, under a load much less than that for which the bridge was designed, makes the question of adequate and safe design, with the proper factor of safety, seem vital. It would be folly to state that the bridge which fell into the Quebec River when stressed only to about $^7/_{10}$ of the values computed for the finished structure, would have stood up under the full live load for which it was designed.

Were the allowed unit stresses in the compression chords of the Quebec Bridge too high? Was the factor of safety used only 1.4? Were the designers justified in considering the chords as short columns, with no additional stress due to bending, therefore no reduction in allowed stress for length ratio?

Of course, in the light of the disaster, it is safe to criticise, but can it be shown that the failure may be partly due to the fact that these compression chords were designed with unusually high allowable unit stresses? Taking the member A 9, for example, we find an allowed unit stress of 12,000 × 1.73 = 20,800 lbs. per sq. in., or 24,000 lbs. per sq. in. for certain possible combinations of loading. What is the comparison between these values and those usually allowed for such chords?

Cooper's specifications allow in chords:

$$\text{For dead load, } P = 20{,}000 - 90\,\frac{l}{r}.$$

$$\text{For live load, } P = 10{,}000 - 45\,\frac{l}{r}.$$

Member A 9 has a length-ratio l/r of 36, as given in Engineering News, p. 288. This results from the theoretical computation for the moment of inertia of the four webs acting together about an axis parallel to them. You have pointed out that the transverse lacing of these chords was entirely inadequate; an application of the formula for lacing-bar stress, developed last week in Engineering News, clearly demonstrates the same fact. Therefore, it is probable that the value of 36 for the length-ratio is decidedly low. Using this low theoretical value, however, we get:

$$\text{For dead load, } P = 16{,}800.$$
$$\text{For live load, } P = 8{,}400.$$

The stress-sheet gives for A 9 a dead load stress of 11,249,000 lbs. and a live load stress of 4,019,000. The total area required would then be:

$$\frac{11{,}249{,}000}{16{,}800} + \frac{4{,}019{,}000}{8{,}400} = 1{,}150 \text{ sq. ins. (ab't.)}.$$

This gives an average unit stress of 13,300 lbs. per sq. in., to be compared with 20,800 allowed in the Quebec Bridge. It is thus evident that Mr. Cooper, as consulting engineer for this bridge, permitted unit stresses in the chords over 1½ times the values allowed by his own General Specifications.

In "Modern Framed Structures," pp. 153a and 153b, J. B. Johnson gives tables and working formulas for the design of steel columns. For pin-ended columns of steel with 42,000 lbs. per sq. in. elastic limit and $l/r = 36$, these give the allowable unit stress as about 10,100. This agrees almost exactly with the allowed stress found from the formula on p. 151:

$$P = \tfrac{1}{4}\left[42{,}000 - 0.97\left(\frac{l}{r}\right)^2\right] = 10{,}200$$

These values are less than one-half of the allowed compression in the Quebec Bridge, though the latter includes the live load, while the working stresses found above are for static loads only. The formula given on p. 322 is of the same type as that used for the Quebec Bridge, and is based on the Pennsylvania R. R. Specifications. It is

$$P = \frac{6{,}500\ (1+\phi)}{1 + \dfrac{p}{18{,}000\ r^2}}$$

for wrought iron. This gives 10,500 lbs. per sq. in., and adding 20% for steel gives 12,600 lbs. per sq. in., which is about ½ of the allowed stress in the Quebec Bridge.

The latest Pennsylvania R. R. specifications give the following for allowed unit-stress in compression members:

$$P = \frac{15{,}000}{1 + \dfrac{p}{13{,}500\ r^2}}$$

For $l/r = 36$, this gives 13,700 lbs. But the maximum stress is to be increased by the factor $1 + k$, where

$$k = \frac{1-\phi}{1+\phi}$$

for stresses of one kind only. For $\phi = 0.73$, $k = 0.156$ and $1 + k = 1.156$. Therefore the equivalent unit-stress is 13,700 ÷ 1.156 = 11,800. This is about the same as the value given above for the older specifications.

Burr's "Elasticity and Resistance of Materials," p. 480, gives the following formula for the value of the ultimate strength of steel built columns, with pin ends:

$$P = \frac{42{,}000}{1 + \dfrac{4\,p}{50{,}000\ r^2}}$$

This gives $P = 38{,}200$, or with factor of safety of 4 an allowable stress of 9,500 lbs. per sq. in. The Quebec Bridge value is 2½ times this allowed stress.

All the above formulas, of course, were based on the results of experiment, as well as on rational discussion of column failure. They indicate that the chord A 9 of the Quebec Bridge was designed with an allowed unit-stress from 1½ to 2½ times as high as is usual in good practice. As an average it is safe to say that the stress of 24,000 lbs. per sq. in. allowed is at least twice as great as that generally deemed safe. This reduces the factor of safety to 2, and in a bridge which would have been a monument to the designers and builders, if successfully completed. Yet this low factor of safety was permitted in columns of a type for which we have absolutely no experimental data, of unprecedented size, and designed to carry enormous loads!

The above discussion has been written for two reasons: First, to defend the civil engineer as a designer of columns, and second, to raise the question as to the allowable safe values or formulas to be used in the design of bridge compression members. The questions of the design of lattice-bars, and of the real strength of a four-web compression member, are still open. The comparative size of the bottom chords of the Quebec Bridge and the Forth Bridge as pictured in Engineering News last week seems to show exceedingly conservative and safe allowed stresses in the Forth Bridge, or else the reverse in the Quebec structure. Is it not far better to build a tremendous bridge of this kind with high factors of safety and plenty of material in the smaller details, which will endure for generations, even though its first cost is more, than to run the risk of a calamity as great as, or greater than, the Quebec disaster? Apparently the modern tendency to "skin" down the material and first cost to the lowest possible point has gone too far.

Very truly yours,

J. P. Williams.

Baltimore Bridge Co.,
Baltimore, Md., Sept. 30, 1907.

[While these comparisons are striking and applicable, the fact must again be emphasized that the primary question before the engineering profession, the failure itself, is not much affected by them. For, as we have already stated, the unit-load on the compression chords which buckled at the time of the collapse was probably not much more than 12,000 lbs. per sq. in. This is far below the designed maximum stresses, and is practically the same as the allowable loadings referred to in the above letter.—Ed.]

Notes and Queries.

In the arrangement of Ostwald's "Table of Potential Difference and Electrolytic Solution Pressure," of metals immersed in solutions of their own salts, presented in the article on the "Corrosion of Iron," in our issue of Sept. 26, the solution pressure of magnesium should be 10^{44} atmospheres instead of 10^{24} as printed.

Mr. C. E. Smith, of San Diego, Cal., writes to us inquiring for some data upon the design of reinforced concrete slab culverts, principally in regard to the distribution of concentrated loads through the earth fill to the top and sides of the culvert. As there may be others who are in search of this same information we print below a list of references from Engineering News bearing directly upon this subject. They consist of both articles upon the design of some particular structures and a symposium of letters in answer to a similar inquiry made some years ago. The references are: V. 52, p. 581; v. 53, pp. 250, 420, 447; v. 55, pp. 6, 570, 600; v. 56, p. 10.

Z. B. G., Newcastle, Pa., writes:

The following mathematical curiosity has given us much fun here that it may do so elsewhere:

Given a sphere of ¼-in. circumference; how far will a circle of one foot and one-half inch circumference drawn concentrically about this little sphere stand away from it?

Answer—About $1^{13}/_{16}$ ins.

Again: Suppose the earth a perfect sphere of 25,000 miles circumference, how much will a circle of 25,000 miles and one foot circumference concentric with the earth stand away from its surface?

Answer—Just the same distance as the circumference of 1 ft. ¼-in. stands away from the little sphere, viz. $1^{13}/_{16}$ ins. Do you believe it?

The only thing that puzzles the editor of Engineering News is why any one should doubt it.

In response to the inquiry of G. W. G. in our issue of Sept. 26, 1907, in regard to the clearance of locomotives around small radius curves, Mr. O. H. Tripp, of Rockland, Me., sends us a tracing of a curve which he put in some nine years ago on the Limerock R. R. in Rockland. This curve is on a standard-gage road and is compounded with three radii, 80, 68 and 74.8 ft. respectively, with a total enclosed angle of about 110°. Mr. Tripp writes further as follows:

I do not make any claim for the curve as a record breaker, but it is the sharpest now in operation to my knowledge. I asked advice from the engineering department of one of the big railroads before it was put in and was assured that a six-wheel connected Baldwin (weighing 40 tons) would not go over such a curve. It was Hobson's choice, however—the track had to go in and there was just so much room for it—and experience has shown that the Baldwin engine passes over it better than some Forney type engines of a different make (and lesser weight). The track is used only occasionally—perhaps two or three times a week—and I think not more than two box cars are moved over it at a time.

ECONOMY TESTS OF A 7,500-KW. WESTINGHOUSE-PARSONS STEAM TURBINE.

By J. R. BIBBINS,* Jun. M. Am. Soc. M. E.

The data herein presented comprises the principal results obtained on Sept. 1, 1907, during an 8-hour economy test upon turbine No. 253, installed earlier in the year, at Waterside station No. 2, of the New York Edison Co., New York City. This test was conducted entirely by the New York Edison Co., under the direction of Mr. J. P. Sparrow, Chief Engineer. The various arrangements therefor were carried out in accordance with a mutual agreement between builder and operator, entered into previous to the test, and the results were obtained by independent computation.

The turbine unit tested is a standard Westinghouse type having a maximum rated capacity of 11,250 KW., and was built to operate on 175 lbs. steam pressure 28 ins. vacuum and 100° superheat. Under these conditions the turbine unit was guaranteed to have a minimum steam consumption of 15.9 lbs. per KW. hr. at the generator terminals with a normal speed of 750 r. p. m. Incidentally, the electrical efficiency of the generator was guaranteed to be 97.8%, exclusive of friction and windage, at a load corresponding to that sustained during the test. The results of the test detailed below show an economy about 7.5% better than the guarantee.

METHODS OF CONDUCTING THE TEST.—During the test period, No. 2 Waterside station sustained practically all of the 25-cycle load on the system. Of this the unit under test carried practically 70%, the other turbine units in the station assuming the remainder. This load was maintained as constant as possible by remote control of the turbine governor by the switchboard operator. Between the first and the last hours of the test the maximum variation in load was held within 4% above and below mean. During the last hour, however, the load decreased somewhat. Previous to the test this turbine unit had been running on a load of 7,000 KW., which was increased to its test load ten minutes before the start.

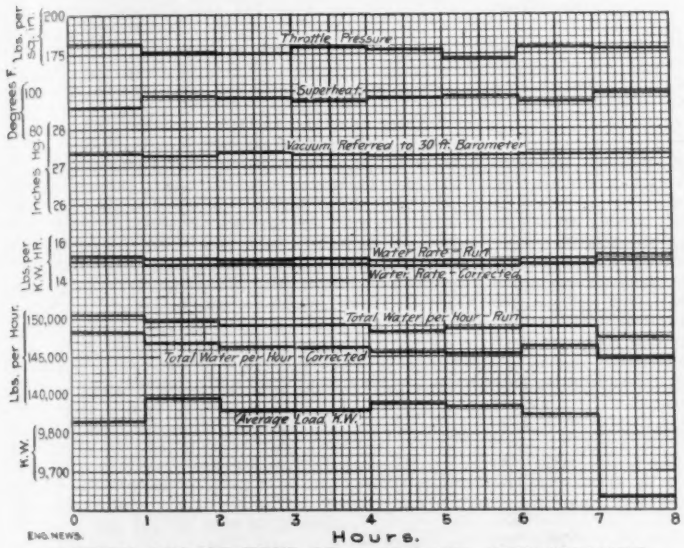
Three-phase electrical load was measured by the two-wattmeter method, using two Weston indicating wattmeters of the standard laboratory type. These instruments were calibrated at the New York Electrical Testing Laboratories immediately before and after the test. Power factor was maintained substantially at unity, and all electrical readings were taken at one-minute intervals.

*Westinghouse Machine Co., East Pittsburg, Pa.

As a surface condenser was used in connection with this turbine unit, the water rate was determined by weighing the condensed steam delivered from the condenser hot well. This condensation was weighed in a tank mounted upon platform scales, with a reservoir above large enough to hold the condensation accumulating between each weighing.

These weighings of 12,000 to 13,000 lbs. each were made at intervals of 5 min. By a loop method of connecting the gland water supply, the necessity for correcting condensation by an amount equivalent to the weight of the gland water used is avoided.

As the circulating water is quite salt, any condenser leakage may immediately be detected by the salinity of the condensed steam, which should be pure distilled water. On this account condenser leakage was determined entirely by chemical analysis, employing the silver-nitrate test with a suitable color indicator. This method proved extremely sensitive and possessed a decided advantage over the ordinary method of weighing the leakage accumulating during a definite period when the condenser is idle and under full vacuum. As samples of circulating water and condensed steam could be taken at the same time, this method made it possible to discover any change in the rate of condenser leakage taking place during the test, while the method of weighing above described provides only an average result during the period.



PLOTTED LOG OF TEST OF A 7,500-KW. WESTINGHOUSE-PARSONS STEAM TURBINE.

In this condensing plant the delivery of the hot well pump is automatically controlled by a float valve in the interior of the hot well. This maintains the water level therein at a practically constant point, and hence no correction had to be made for difference in level of water in the hot well before and after the test.

Steam pressures and temperatures were determined close to the turbine throttle. As usual, the degree of superheat was obtained by subtracting from the actual steam temperature the temperature of saturated steam at the corresponding pressure carried at the time. All gages and thermometers were calibrated previous to the test at the U. S. Testing Bureau. It will be noted that both pressure and superheat were somewhat below the guarantee.

Vacuum was measured directly at the turbine exhaust by means of a mercury column with a barometer alongside for reducing to standard barometer—30 ins. This also obviated the necessity for temperature correction between the two mercury columns. During the test the vacuum was not maintained quite up to normal.

RESULTS OF TESTS.—The following data represents the results of the tests, calculated for the conditions as actually run, i. e., for instrumental errors only:

Duration of test	9.30 a. m. to 5.30 p. m.
Avg. steam pres. at throttle, lbs. per sq. in. gage	177.5
Avg. superheat at throttle, degrees F	96.74
Avg. vacuum (referred to 30 in. barom.) in Hg.	27.31
Avg. load on generator, KW	9,850.48
Avg. steam consmptn, as tested, lbs. per KW.-hr.	15.15

Owing to the departure, during the test, from specific operating conditions upon which guarantees were based, it was necessary to correct the observed results by the following amounts:

Pressure (2.5 lbs. high) correction, 0.25%; vacuum (0.69-in. low) correction, 1.84%; superheat (4.26° low) correction, 0.29%.

These corrections were mutually agreed upon previous to the test as representative of this type of turbine. When applied to the observed steam consumption given above, the following results, representing contract conditions, are obtained:

Avg. corrected water rate during 8-hour test	14.85 lbs. per KW.-hr.
Guaranteed water rate	15.9 lbs. per KW.-hr.

Referring now to the accompanying log, it is interesting as a check upon the average figures above presented to observe the results segregated into hourly periods, as shown. Here it will be noted that the load was considerably lower during the first and last hour than during the main part of the test. Neglecting, therefore, these two hours and considering only the six-hour period from 10.30 a. m. to 4.30 p. m., the results are as follows:

Avg. corrected water rate	14.8 lbs. per KW.-hr.
Equivalent water rate	10.65 lbs. per B. HP.-hr.
Equivalent water rate	9.8 lbs. per I. HP.-hr.

The two latter quantities are determined by applying conversion factors for generator efficiency and for internal losses.

In connection with these tests a noteworthy agreement exists between the results noted and those previously obtained from tests of machines of similar design installed in the Manhattan station of the Interborough Rapid Transit Co., New York, and the Long Island City station of the Pennsylvania R. R. At the same loads and with equivalent operating conditions the performance of the machines is almost identical. These economic results, while not exceeding in actual steam consumption to best records of European practice, yet are considered extremely good by the manufacturers, in view of the operating conditions under which the test was conducted and are held to represent the best results that have yet been obtained by any turbine under the conditions named.

A PRODUCTIVE MICA MINE, yielding mica of high quality, is reported by Consul H. D. Van Sant at Sydenham, Ont., about 16 miles from Kingston. The mine, said to be the largest mica mine in the world, yields mostly amber mica, with some silver-amber (the highest quality). The output is nearly all exported to American electrical manufacturers.

A NEW CEMENT SCREEN has recently been put on the market in which the old principle of screening has been radically changed. The old screens are made of meshed wire enclosed in a frame, and the screening process is carried on by shaking the whole frame, until the smaller material passes through the meshes. In the new screen, the frame carrying the mesh is held rigid and the material agitated by a series of small hammers, which continually tap the protected surface of the wire. In this way the openings have small opportunity to clog, on account of the continual vibration at all points on the screening surface. The framework is adjustable at various inclinations, and as the wires which make up the mesh are quite large, in comparison with the stationary screens, the horizontal surface of the openings exposed varies as the inclination, thus regulating the size of the mesh and the fineness of the output. The uniformity of the distribution of the vibration should increase the age of usefulness of the device over that of the old one. Mr. W. J. Bell, of Newago, Mich., is the inventor of the screen.

PRESIDENT ROOSEVELT ON IMPROVEMENT OF NATIONAL WATERWAYS*

The Mississippi Valley is a magnificent empire in size and fertility. It is better adapted to the development of inland navigation than any other valley in either hemisphere, for there are 12,000 miles of waterway now more or less fully navigable, and the conditions are so favorable that it will be easy to increase the extent of navigable waterways to almost any required degree by canalization.

Early in our industrial history this valley was the seat of the largest development of inland navigation in the United States, and perhaps you will pardon my mentioning that the first steamboat west of the Alleghenies was built by a Roosevelt, my great-grandfather's brother, in 1811, for the New Orleans trade, and in that year made the trip from Pittsburg to New Orleans.

But from various causes river and canal transportation declined all over the United States as the railroad systems came to their full development. It is our business to see that the decline is not permanent.

The Mississippi River and its tributaries ought by all means to be utilized to their utmost possibility. Facility of cheap transportation is an essential in our modern civilization, and we cannot afford any longer to neglect the great highways which nature has provided for us. These natural highways, the waterways, can never be monopolized by any corporation. They belong to all the people, and it is in the power of no one to take them away. Wherever a navigable river runs beside railroads the problem of regulating the rates on the railroads becomes far easier, because river regulation is rate regulation.

Year by year transportation problems become more acute, and the time has come when the rivers really fit to serve as arteries of trade should be provided with channels deep enough and wide enough to make the investment of the necessary money profitable to the public.

The national government should undertake this work. Where the immediately abutting land is markedly benefited, and this benefit can be definitely localized, I trust that there will be careful investigation to see whether some way can be devised by which the immediate beneficiaries may pay a portion of the expense—as is now the custom as regards certain classes of improvements in our municipalities; and measures should be taken to secure from the localities specially benefited proper terminal facilities.

The expense to the nation of entering upon such a scheme of river improvement as that which I believe it should undertake will necessarily be great. Many cautious and conservative people will look askance upon the project, and from every standpoint it is necessary, if we wish to make it successful, that we should enter upon it only under conditions which will guarantee the nation against waste of its money, and which will insure us against entering upon any project until after the most elaborate expert examination, and reliable calculation of the proportion between cost and benefit.

We should act on the same principle in improving our rivers that we should follow in improving our harbors. The great harbors are of consequence not merely to the immediate localities, but to immense stretches of country, and the same is true of the great rivers. The main streams should be improved to the highest practical degree of efficiency before improvements are attempted on the branches, and work should be undertaken only when completion is in sight within a reasonable time, so that assured results may be gained and the communities affected depend upon the improvements.

Immense sums have already been spent upon the Mississippi by the states and the nation, yet much of it remains practically unused for commerce. The reasons for this fact are many. One is that the work done by the national government at least has not been based upon a definite and continuous plan. Appropriations by Congress, instead of assuring the steady progress and timely completion of each piece of work, as it was undertaken, have been irregular and uncertain. As a direct consequence, far reaching plans have been discouraged and continuity in execution has been made impossible.

It is altogether unlikely that better results will be obtained so long as the method is followed of making partial appropriations at irregular intervals for works, which should never be undertaken until it is certain that they can be carried to completion within a definite and reasonable time. Planned and orderly development is essential to the best use of every natural resource, and to none more than to the best use of our inland waterways. In the case of the waterways it has been conspicuously absent.

Because such foresight was lacking the interests of our rivers have been in fact overlooked, in spite of the immense sums spent upon them. It is evident that their most urgent need is a farsighted and comprehensive plan, dealing not with navigation alone, nor with irrigation alone, but considering our inland waterways as a

*Extracts from address delivered before the Lakes to the Gulf Deep Waterway Association at Memphis, Oct. 4.

whole, and with reference to every use to which they can be put. The central motive of such a plan should be to get from the streams of the United States not only the fullest but also the most permanent service they are capable of rendering to the nation as a whole.

The railroads have shown that they alone cannot meet the demands of the country for transportation, and where this is true the rivers should begin to supplement the railroads, to the benefit of both, by relieving them of certain of the less profitable classes of freight. The more farseeing railroad men, I am glad to tell you, realize this fact, and many of them have become earnest advocates of the improvement of the Mississippi, so that it may become a sort of inland seaboard, extending from the Gulf far into the interior, and I hope ultimately to the Great Lakes. An investigation of the proposed Lakes-to-the-Gulf deep waterway is now in progress under an appropriation of the last Congress. We shall await its results with the keenest interest. The decision is obviously of capital importance to our internal development and scarcely less so in relation to external commerce.

Plans for the improvement of our inland navigation may fairly begin with our greatest river and its chief tributaries, but they cannot end there. The lands which the Columbia drains include a vast area of rich grain fields and fruit lands, much of which is not easily reached by railways. The removal of obstructions in the Columbia and its chief tributaries would open to navigation and inexpensive freight transportation fully two thousand miles of channel.

The Sacramento and San Joaquin Rivers with their tidal openings into San Francisco Bay are partly navigable now. Their navigation should be maintained and improved, so as to open the marvellously rich valley of California to inexpensive traffic, in order to facilitate both rate regulation and the control of the waters for other purposes.

There are other questions of no less consequence connected with our waterways. One of these relates to the purity of waters used for the supply of towns and cities, to the prevention of pollution by manufacturing and other industries, and to the protection of drainage areas from soil wash through forest covering or judicious cultivation. With our constantly increasing population this question becomes more and more pressing, because the health and safety of great bodies of citizens are directly involved.

Another important group of questions concerns the irrigation of arid lands, the prevention of floods and the reclamation of swamps. Already many thousands of homes have been established on the arid regions, and the population and wealth of seventeen states and territories have been largely increased through irrigation. Yet this means of national development is still in its infancy, and it will doubtless long continue to multiply homes and increase the productiveness and power of the nation.

The reclamation of overflow lands and marshes, both in the interior and along the coasts, has already been carried on with admirable results, but in this field, too, scarcely more than a good beginning has yet been made. Still another fundamentally important question is that of water power. Its significance in the future development of our whole country, and especially of the West, is only just beginning to be understood. The plan of the city of Los Angeles, for example, to bring water for its use a distance of nearly 250 miles—perhaps the boldest project of the kind in modern times—promises not only to achieve its purpose, but in addition to produce a water power sufficiently valuable to pay large interest on the investment of over $23,000,000.

Hitherto such opportunities for using water to double purpose have not always been seized. Thus it has recently been shown that water enough is flowing unused over government dams, built to improve navigation, to produce many hundreds of thousands of horse-power. It is computed that the annual value of the available but unused water power in the United States exceeds the annual value of the products of all our mines. Furthermore, it is calculated that under judicious handling the power of our streams may be made to pay for all the works required for the complete development and control of our inland waterways.

Forests are the most effective preventers of floods, especially when they grow on the higher mountain slopes. The national forest policy, inaugurated primarily to avert or mitigate the timber famine which is now beginning to be felt, has been effective also in securing partial control of floods by retarding the run-off and checking the erosion of the higher slopes within the national forests. Still the loss from soil wash is enormous. It is computed that one billion tons in weight, of the richest soil matter of the United States is annually gathered in storm rivulets, washed into the rivers and borne into the sea. The Department of Agriculture is now devising and testing means to check this enormous waste through improved methods of agriculture and forest management.

The Inland Waterways Commission was created in March last, largely in response to petitions from citizens of the interior, including many of the members of this Congress. Broad instructions were given to the commission in accordance with this general policy that no plan should be prepared for the use of any stream for a single purpose without carefully considering, and so far as practicable actually providing for, the use of that stream for every other purpose. Plans for navigation and power should provide with special care for sites and terminals not only for the immediate present but also for the future. It is because of my conviction, in these matters that I am here. The Inland Waterways Commission has a task broader than the consideration of waterways alone. There is an intimate relation between our streams and the development and conservation of all the other great permanent sources of wealth. It is not possible rightly to consider the one without the other. No study of the problem of the waterways could hope to be successful which failed to consider also the remaining factors in the great problem of conserving all our resources. Accordingly, I have asked the Waterways Commission to take account of the orderly development and conservation, not alone of the waters, but also of the soil, the forests, the mines and all the other resources of our country.

NINE MINERS WERE DROPPED TO THE BOTTOM of a deep shaft at the Foggs colliery, Bolton, England, on Oct. 4. The cable slipped off the sheave and the cage fell to the bottom, in which the water was 70 ft. deep. The miners were drowned.

AN EXPLOSION caused by the upsetting of the metal pot in No. 1 cupola of the Standard Steel Co. at Butler, Pa., on Oct. 6, caused the instant death of four men, the fatal injury of 20 and the serious injury of ten. The wheel plant was demolished with an estimated loss of $100,000.

An explosion occurred at the Union Furnace Co.'s plant at Buffalo on the same day, when an Italian foreman of a gang blasting slag attempted to drive home a 25-lb. dynamite cartridge with a sledge hammer. He and a laborer were killed, and five others injured.

KOREA CONTRIBUTED THE WORST RAILWAY wreck reported during the past week. Details are meager, but the press report states that, by the derailment of a train near Seoul on Oct. 1, 42 persons were killed or injured, 30 of whom were Japanese soldiers.

The north-bound Florida-West Indian limited train on the Atlantic Coast Line R. R. ran into an open switch at Rocky Mount, N. C., on Oct. 6, and collided with a yard engine. Both engines and three cars were demolished, and the engineer of the passenger train was killed.

FLOODS OF UNUSUAL SEVERITY, and entailing great loss of life, are reported simultaneously from France, Spain and Japan. Press dispatches from Madrid, dated Sept. 26, report that about 100 persons were drowned, and bridges, houses, and even entire villages, were swept away by the Guadalmedina River, swollen by heavy rains to a width of three miles. From Agde, France, comes the report that the valley of the Herault River was flooded, with enormous losses to property and vineyards. A 50-ft. rise in the Otonashigawa River, near Kyoto, Japan, was reported on Sept. 27; 600 lives are said to have been lost.

THE COLLAPSE OF A STEEL VIADUCT in Atlanta, Ga., on Sept. 27, was caused by the derailment of a loaded coal car, on the tracks of the Southern Ry., which struck one of the steel columns supporting the viaduct. The structure, known as the Jones Ave. bridge, was supported at the center by three steel columns; it was paved with Belgian blocks, and carried street-car tracks. A loaded electric car had just crossed, and two teams were on the bridge, when the car—in the center of a train passing beneath—left the track and struck one of the three columns; the other columns gave way and the bridge fell.

THE BESSEMER DEPARTMENTS of the Duquesne and the Homestead steel works of the U. S. Steel Corporation were closed down on Sept. 27. It is reported that the latter plant will reopen in 30 days, but not permanently; the former will be dismantled and a new open-hearth furnace will take its place. Scarcity of high-grade iron ore, necessary to steel production by the Bessemer process, is reported as the cause of the closure of the plants; ore treated by this process must contain very small amounts of carbon, phosphorus and sulphur. The open-hearth process is adaptable to the production of high-grade steel from low-grade ore.

EXTENSION OF ELECTRIC TRACTION on the New York Central Railroad beyond the present "electrified zone" in New York City appears probable. These extensions will be to North White Plains on the Harlem division and to Croton on the Hudson division, and depend on the elimination of grade crossings at Mt. Vernon, Tuckahoe and White Plains on the former division and at Ossining and Tarrytown on the latter. Orders for some of these eliminations have been issued by the Public Service Commission and undoubtedly the remaining questions will soon be settled. The work of extension will require some two years.

GREAT LAKES COMMERCE during August, 1907, was heavier than for any summer month recorded by the Bureau of Statistics of the Department of Commerce and Labor. The total volume of shipments was 39,787,800 net tons, which is 10% larger than the volume for July of this year, more than 15% larger than for August, 1906, and 33% larger than for August, 1905. For the eight months ending Aug. 31, 1907, the total was 50,441,041 net tons; this is about 14% and 24% larger respectively than the corresponding totals for 1906 and 1905.

Large shipments of coal and iron ore during August were responsible for the great excess over August, 1906. Iron-ore shipments, mainly from the Lake Superior ports of Ashland, Duluth, Marquette, Superior and Two Harbors, and the Lake Michigan port of Escanaba, aggregated 6,950,300 gross tons, against 5,533,400 gross tons for August, 1906, and 6,228,200 gross tons—previously the record figure—for June, 1907. Up to Sept. 1, 1907, shipments of iron ore amounted to 24,466,200 gross tons—over 2,500,000 tons in excess of the corresponding figures for 1906; labor troubles at the Lake Superior district mines prevented an even greater excess.

PANAMA CANAL WORK DURING SEPTEMBER has just been reported by Chief Engineer Goethals. Below are summarized the amounts during August and September. It should be noted that the excavation in August was at that time the record monthly amount since the American occupation. The rainfall in the two months was practically the same, viz., 11.9 ins.

	Amount in cu. yds. August.	September.
Excavation—		
Culebra	786,866	753,278
Gatun	105,223	129,758
Mindi, Chagres and La Boca..	24,861	55,814
Dredging—		
Colon division	189,170	403,852
La Boca division	168,284	144,625
Total	1,274,404	1,481,307

This shows a total increase in excavation of 206,903 cu. yds., 191,023 of which are in dredging and only 15,880 in steam shovel work. This large increase in dredging work is due to the installation of the new suction dredge on the Colon division. It should be remembered, however, that there were only 24 working days in September against 27 in August, so that the daily total excavation increased about 31%.

THE DETROIT RIVER TUNNEL of the Michigan Central R. R. had its first river section sunk in place on Oct. 1. The approaches are being tunneled in the usual way, but the river section will consist of a pair of single-track steel tubes built as one double-track structure and sunk upon an I-beam and concrete grillage at the bottom of a deep trench dredged across the river. The tubes will be encased and covered with concrete. There will be ten sections, each 260 ft. long, and two will probably be placed this season. The first section was at the Detroit shore end. It was held in position by cables led to a hoisting engine on shore and to anchors in the stream, the engine adjusting the strain on the cables to keep the structure in position as it sank. The ends were closed with timber bulkheads fitted with valves, and large steel tanks were attached to the top for additional buoyancy. The shore end sank more rapidly than the other, and dropped suddenly at one stage of the proceedings. The pumps restored the buoyancy and the end rose until the structure floated level. The final adjustment and sinking to permanent position was completed on Oct. 2. The work is being done by Butler Bros. & Hoff, of New York, under the direction of Mr. W. S. Kinnear, M. Am. Soc. C. E., Chief Engineer and General Manager of the Detroit River Tunnel.

A FACTORY IN 29 DAYS is the building record of the contractors for the new lamp factory of the General Electric Company in Newark, N. J. In 29 calendar days after the first ground was broken the company's machinery was being installed, and this with no night or Sunday work. A half-holiday was given each Saturday for the skilled labor. The footings were originally specified as 4 ft., 6 ins. deep, but owing to the discovery that the site was that of an ancient tannery the footings were made 16 ft. deep, and it was found necessary to excavate large quantities of old tan bark. In spite of this, the foundations were completed two days ahead of the original time allowance. Although the building is at present only a single story in height, the foundations and walls were made strong enough for the addition of three more stories at a later date. Some 280 men were employed in building the structure, under the supervision of four brick foremen, four carpenter foremen and four general labor foremen; 400,000 bricks were laid in eleven working days, or about 36,000 bricks per day. Two timekeepers were continually employed, and one of the firm of contractors was always on the ground. Standard mill construction was used, with 14 × 14-in. posts, 16 × 16-in. girders and 10 × 16-in. beams. Sleepers of 3 × 4-in. long-leaf yellow pine, 18 ins. c. to c., were imbedded in concrete, and on these 1¼-in. maple flooring was laid. A temporary roofing of hemlock with the final covering and

a 4-in. tar concrete floor were completed in four days. This building speed is attributed in part to the ability of the contractors to buy the hard brick, yellow pine, Portland cement, window and door frames and all trimmings in Newark for immediate delivery. The factory covers about one acre of ground and the cost was approximately $50,000. Messrs. Wilson, Harris & Richard, of Philadelphia, were architects for the General Electric Co., and Salmond Bros., of Newark and Arlington, N. J., were the contractors.

TWENTY-EIGHT HEAVY ELECTRIC LOCOMOTIVES have just been installed in Vesta Mine No. 4, of the Jones & Laughlin Steel Co., at California, Pa., and the mine—said to be the largest coal mine in output in the country—will now be run to its maximum capacity of 7,000 tons per day. To handle the heavy traffic the tracks throughout the mine have been changed from 60-lb. to 90-lb. rails. There are 85 miles of track in the mine, not including some 120,000 ft. of movable track which brings the total mileage up to 109. The record output of the mine for a month is 174,338 tons, and for one day 7,225 tons.

WORK ON THE KEY WEST EXTENSION of the Florida East Coast R. R. is progressing rapidly, according to Mr. J. R. Parrott, Vice-President and General Manager of the road. To hasten the completion of that portion of the extension between the mainland and Knight's Key, the forces and machinery were transferred from both ends of the line and concentrated on that section; the line will be complete as far as Knight's Key by Jan. 15, it is expected, and boats will then run between Knight's Key and Cuba. Of the southern end of the extension, between Key West and Knight's Key, 80% is practically completed—i. e., the 47 miles between Key West and Bahia Honda. From Bahia Honda to Knight's Key the distance is twelve miles, within which lie the three yet unbuilt concrete viaducts. The viaduct across the Long Key opening, longer than any of the others, is about completed.

There are 2,500 men employed on the work at present, against about 1,600 at the same time last year. Mr. J. C. Meredith is Chief Engineer in charge.

THE IRRIGATION OF 25,000 ACRES of Texas rice land, with water supplied by two Allis-Chalmers centrifugal pumps, has been undertaken by the Wharton Irrigation Co. The plant will be located about two miles from Wharton, and the land is owned by the Pierce estate; Mr. John W. Maxcy, of Houston, is Consulting Engineer of the project. It is planned to build 15 miles of main canal this year, for the irrigation of next year's crop. The machinery equipment consists of two 36-in. double-suction centrifugal pumps, each driven by a cross-compound "Reliance" engine; each unit will have a normal capacity of 50,500,000 gals. per day of 24 hours, against a 35-ft. head, working on a steam pressure of 150 lbs. The pumps proper are located between the high and the low pressure-cylinders of the engines, and mounted directly upon the shafts; when running, the filled pump runners supply all necessary fly-wheel effect. Five such units will eventually be installed.

A THIRD LARGE DAM is projected for the Missouri River, near Helena, Montana. Power there developed will augment the already large present output; and a part, it is stated on authority of ex-Gov. Samuel T. Hauser, will be used to operate the projected Helena-Butte electric railway. Amalgamated Copper interests are said to be largely behind the projected power development, and also the electric road. The latter will tap Corbin, Boulder, Basin, and other well-known mining districts between Helena and Butte.

THE TOTAL ASPHALT PRODUCTION in the United States in 1906 was 138,059 tons, valued at $1,290,340; for 1905 the figures were 115,265 tons and $758,153; the increase was 20% in quantity and 70% in valuation. In computing these figures, the U. S. Geological Survey has used the term asphalt to include all varieties—natural and refined, liquid, semi-liquid and solid; from the nearly pure bitumen or oil-asphalt to the bituminous sandstones and limestones. The figures for the different varieties are given in the following table:

	Tons.	Value.
Bituminous sandstone	24,085	$70,686
Mastic	2,543	24,158
Hard and refined, or gum	24,178	341,106
Liquid or maltha	9,900	86,750
Wurtzilite, Gilsonite	12,947	159,960
Grahamite	1,952	16,432
Oil asphalt	62,454	591,248
	138,059	$1,290,340

California leads in the production of oil asphalt, producing 62,361 tons of the amount shown in the table and showing a large increase over the production for 1905. About two-thirds of the asphalt imported to this country is from the well-known pitch lake on the island of Trinidad. The Geological Survey will soon have ready for distribution an advance chapter for "Mineral Resources of the United States," prepared by Joseph A. Taff, and treating this subject in detail. Copies may be obtained without cost from the Director at Washington.

A SURFACE-CONTACT ELECTRIC RAILWAY system for city streets has been approved by the Highways Committee of the London County Council (England) and is to be used on the new municipal street railway line from Aldgate to Bow Bridge. The conductor cable is supported on insulators in a 5-in. vitrified pipe conduit, made watertight by bituminous packing at the joints. At intervals there are T-shaped studs, having the head flush with the paving, while the end of the steam is forked and fits over the cable. As the car passes over each stud, a magnet forces a contact piece down upon it, so as to press the stud down upon the cable. In case of a "live" stud, a brush at the front end of the car will disconnect the circuit and thus stop the car. The underground conduit system now used in the busy parts of London requires excavation to a depth of 33 ins., while the new system can be built in a 16-in. trench. The cost of the Griffiths & Bedell surface-contact system is said to be $52,500 per mile of track, as compared with $85,000 for the conduit system, and $49,500 for the trolley system.

PERSONALS.

Mr. W. G. Wallace, Superintendent of Motive Power of the Ann Arbor R. R., has resigned.

Mr. F. R. Meier has opened an office as consulting forester, at 1 Broadway, New York City.

Mr. R. S. Davis has been appointed Terminal Engineer of the Mexican Central Ry., at El Paso.

Mr. W. J. Buchanan, Master Car Builder of the Bessemer & Lake Erie R. R., has resigned; Mr. F. W. Dickinson succeeds him.

Mr. C. J. Rhodin, M. West. Soc. E., has been appointed Supervising Engineer of the Department of Engineering of the State of California.

Mr. J. T. Burke, formerly with the Southern Pacific Co., has been elected President of the Peninsular Electric Ry. Co., of San Jose, Cal.

Mr. Washington Paulison has resigned as Superintendent of the Acquackanonk (N. J.) Water Co. He is succeeded by Mr. W. C. Hopper, of the Passaic Water Co.

Mr. W. J. Young, Chief Engineer of the Lehigh & New England R. R., has resigned to become Chief Engineer of the Alpha Portland Cement Co., at Martin's Creek, Pa.

Mr. Francis C. Lincoln, M. Am. Inst. M. E., of New York City, has been appointed Professor of Geology and Mineralogy at the Montana State School of Mines, at Butte.

Mr. H. S. Blaiklock, General Superintendent of the eastern division of the Grand Trunk Pacific Ry., has been appointed Engineer of Maintenance of Way for the entire system.

Mr. John Schulz has been appointed Assistant City Engineer of Seattle, in charge of the bridge work of the city. Mr. Schulz was for five years with the American Bridge Co.

Mr. C. L. Rogers, formerly Superintendent of the Uxbridge & Blackstone (Mass.) Street Ry. Co., is now Superintendent of the Worcester & Blackstone Street Ry. Co., at Worcester.

Mr. James Grant, formerly Secretary, is now General Superintendent of the Kalamazoo, Lake Shore & Chicago Ry., with offices at South Haven, Mich. He succeeds Mr. Blaine Gavett.

Mr. H. E. Whittenberger, Division Superintendent on the Kansas City Southern Ry. at Pittsburg, Kan., has resigned to take a similar position with the Grand Trunk Pacific Ry. at Montreal.

Mr. A. A. Tisdale has been appointed Assistant to the Vice-President and General Manager of the Grand Trunk Pacific Ry., with headquarters at Montreal. He has been Assistant to the Fourth Vice-President.

Mr. H. H. Vreeland, formerly President of the New York City Ry. Co., and retained by the receivers of that company as General Manager, resigned on Oct. 4. Mr. Oren Root succeeded him as General Manager.

Mr. Louis M. Richard, formerly an engineer with the Steptoe Valley Smelting & Mining Co., at McGill, Nev., has been appointed Professor of Mining Engineering at the North Georgia Agricultural College, at Dahlonega.

Messrs. Percy H. Thomas, M. Am. Inst. E. E., and N. J. Neall, Assoc. Am. Inst. E. E., have formed the firm of Thomas & Neall, Electrical Engineers, with offices at 52 William St., New York City, and 12 Pearl St., Boston.

Mr. W. S. Andrews has been appointed General Superintendent of Transportation of the Cincinnati, New Orleans & Texas Pacific Ry., with offices at Cincinnati. His former position of Assistant to the General Manager is now abolished.

Mr. T. H. Brown, a draftsman with the Baltimore & Ohio R. R., has been promoted to the position of Assistant Engineer of the Pittsburg division, succeeding Mr. L. E. Haislip, transferred to the Wheeling division. Mr. Haislip succeeds Mr. J. J. Smiley, resigned.

Mr. J. C. Huffman, Assoc. Am. Inst. E. E., Electrical Engineer of the Oneonta & Mohawk Valley R. R. Co., at Oneonta, N. Y., has resigned to become a sales engineer with the Canadian Westinghouse Co., at the Winnipeg office. His headquarters will be at Calgary, Alberta.

Mr. H. W. Durham has resigned as Resident Engineer at Panama with the Isthmian Canal Commission, to accept a position with the firm of Wm. Barclay Parsons, New York City, in charge of preliminary work on the Cape Cod Canal. His headquarters will be at Sandwich, Mass.

Mr. Harry Schley Sanderson has been appointed Supervisor of City Lighting of St. Louis, to succeed Mr. Thomas B. Carter. Mr. Sanderson is President of the Electrical Expert Inspection & Maintenance Co., and is a graduate of the Electrical Engineering Course at the Massachusetts Institute of Technology.

Messrs. Arthur B. White, Assoc. M. Am. Soc. C. E., and Wm. F. Bixby have organized the firm of Bixby & White, Civil and Hydraulic Engineers, with offices in the San Fernando Bldg., Los Angeles. They will make a specialty of structural steel and reinforced-concrete construction, irrigation and sewerage systems.

Mr. Clarence W. Hubbell, M. Am. Soc. C. E., Civil Engineer to the Board of Water Commissioners of Detroit, has resigned to go to Manila, P. I., there to take entire charge of the city water system. He will be succeeded at Detroit by Mr. Geo. H. Fenkel, at present Civil Engineer of the water department at Erie, Pa.

Mr. John Severin Branne, Assoc. M. Am. Soc. C. E., for the past five years Secretary and Chief Designing Engineer of the Jas. E. Brooks Co., Consulting Engineers, 45 Broadway, New York City, has resigned and opened an office at 1 Madison Ave., New York City, as a consulting engineer, making a specialty of bridges, buildings and general structural work.

Mr. T. G. Eger, Vice-President and General Manager of the Clyde S. S. Co., has retired on account of his health. He will be succeeded by Mr. H. H. Raymond, at present General Manager of the Mallory Line. Mr. Eger, in 1861, worked his way from Germany to America on a sailing ship, when but 13 years old; in 1872 he was Freight Solicitor for the Clyde Line, and a few years later became General Manager.

Messrs. A. H. Smith and J. H. Hustis, Vice-President and General Manager and General Superintendent of the western division, respectively, of the New York Central & Hudson River R. R., have been appointed General Manager and Assistant General Manager of the Boston & Albany R. R. Mr. Hustis will have headquarters at Boston; Mr. Smith will retain his present title with the New York Central and perform the duties associated therewith.

Mr. Wm. Schlafge, whose promotion from General Master Mechanic of the Erie R. R. to Assistant Mechanical Superintendent at Meadville we noted on June 6, has been made Mechanical Superintendent of the Grand division and of the New York, Susquehanna & Western, with office at Jersey City. Mr. T. Rumney, former Mechanical Superintendent at Meadville, has been made General Mechanical Superintendent of all lines, with office at New York City. Mr. A. G. Trumbull, also an assistant to Mr. Rumney at Meadville, has been made Mechanical Superintendent of the Ohio division and the Chicago & Erie, with office at Cleveland.

The following transfers are ordered in the Corps of Engineers, U. S. A.: Capt. Jas. B. Cavanaugh, now at Montgomery, Ala., in charge of rivers and harbors of the Gulf Division, to duty at the office of the Chief of Engineers at Washington, succeeded by Capt. Harry B. Ferguson at present on duty at Montgomery under Capt. Cavanaugh's orders; First Lieut. Wm. G. Caples, Gulf Division, from duty under orders of Maj. W. W. Harts and to Mobile for duty; First Lieut. W. T. Hannum, from duty in charge of construction of defenses at Guantanamo Bay, Cuba, to Washington Barracks for duty with the companies of the Second Battalion of Engineers; First Lieut. T. H. Dillon, from duty at the Engineer School, Washington Barracks, to Havana for duty with companies of Second Battalion now in Cuba; Second Lieut. J. T. Bain to the Philippines, sailing Nov. 5.

Mr. Wm. H. Arnold, M. Am. Soc. C. E., whose resignation as Chief Engineer of the Bush Terminal Co. we noted on June 6, has opened offices with Mr. Harold S. Andrew at 52 Broadway, New York City, under the firm name of Arnold & Andrew, Consulting Engineers. They will specialize in designs of all types of dredges and dredging machinery, water-front improvement, drainage, etc. Mr. Arnold has been engaged especially upon work of this kind for the past twelve years, along the Atlantic coast; he has during that time made various valuable improvements in dredging machinery, several of which have been described in our columns. Mr. Andrew is a graduate of New York University, Class of '87, with degrees of B. S. and C. E.; he has been identified ever since with the U. S. Engineer Department in the im-

provement of New York Harbor and adjacent waters, and has been connected with hydrographic surveys of practically all of the navigable rivers and harbors in the New York and New Jersey districts, having local charge of dredging, etc. Mr. Andrew was recently connected with the final surveys of the Ambrose Channel to New York Harbor.

Obituary.

Alexander M. Fox, of Philadelphia, the oldest director of the Pennsylvania R. R. Co., died on Oct. 6 at Philadelphia within one day of his eighty-third birthday.

George Richardson Strachan, M. Inst. C. E., a well-known English consulting engineer on water and sewage practice, died on Sept. 20 at the age of 50. Mr. Strachan will be recalled by readers of Engineering News through his report on the Toronto sewage problem, abstracts of which appeared in our issue of Sept. 6, 1906.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.
Oct. 14-18. Annual convention of this and affiliated association at Atlantic City, N. J. Secy., Bernard V. Swenson, 29 West 39th St., New York City.

AMERICAN STREET AND INTERURBAN RAILWAY ENGINEERING ASSOCIATION.
Oct. 14-16. Annual convention at Atlantic City, N. J. (See preceding item). Secy., S. W. Mower, Southwestern Traction Co., London, Ont.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
Oct. 15-17. Annual meeting at Milwaukee. Secy., S. F. Patterson, Concord, N. H.

AMERICAN GAS INSTITUTE.
Oct. 16-18. Second annual meeting at Washington, D. C. Secy., Jas. W. Dunbar, New Albany, Ind.

AMERICAN ELECTROCHEMICAL SOCIETY.
Oct. 17-19. Annual fall meeting at New York City. Secy., Prof. J. W. Richards, Bethlehem, Pa.

NATIONAL RAILWAY WATER SUPPLY ASSOCIATION.
Oct. 22-23. Annual meeting at Beloit, Wis. Secy., F. W. Hayden, Glencoe, Minn.

AMERICAN PEAT ASSOCIATION.
Oct. 23-26. Convention for organization at Jamestown Exposition. Address Julius Bordollo, Kingsbridge, New York City.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION.
Nov. 11-14. Twenty-fifth annual convention at Chicago. Secy., W. E. Emery, C. & A. Ry., Kansas City, Mo.

AMERICAN MINING CONGRESS.
Nov. 11-16. Tenth annual convention at Joplin, Mo. Secy., J. F. Calbreath, Jr., Denver.

AMERICAN CIVIC ASSOCIATION. }
NATIONAL MUNICIPAL LEAGUE. }
Nov. 19-21. Joint convention at Providence, R. I. Secy., Clinton R. Woodruff, North American Building, Philadelphia.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 22-23. Annual meeting at New York City. Secy., W. J. Baxter, 29 West 39th St., New York City.

SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 5-7. Convention at Chicago. Secy., C. R. Richards, Columbia University, New York City.

BOSTON SOCIETY OF CIVIL ENGINEERS.—At a regular meeting held on Sept. 18, in Tremont Temple, Mr. Herman K. Higgins, Assoc. M. Am. Soc. C. E., Assistant Engineer on the Gatun Locks division of the Panama Canal, gave an informal talk on "Panama from the Human Side." His talk was illustrated with a large number of lantern slides.

AMERICAN CHEMICAL SOCIETY.—The New York Section will hold its first regular meeting of the season on Oct. 11, at 8:15 p. m., at the Chemists' Club, 108 West 55th St., New York City. Three papers will be presented: "Some Transmutations of the Past Century," by Chas. Baskerville; "Ignition Temperatures of Gaseous Mixtures" (second paper), by Dr. K. G. Falk; and "Discussion of Dr. Falk's Results with Reference to Their Bearing upon Gas-Engine Problems," by Dr. C. E. Lucke.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The topic of the meeting held on Tuesday evening, Oct. 8—"Industrial Education"—called forth much animated discussion after the speaker of the evening, Prof. John Price Jackson, of the Pennsylvania State College, had delivered his address. As we stated in the last issue, his address quoted largely from letters from manufacturing companies anent so-called "student apprenticeship courses"; and the gist of them all was that the manufacturers go to the trouble and expense of maintaining these courses because it pays—for no other reason. Engineering graduates have to be trained in fundamental practical work: the courses do that. Prof. Jackson's brother, Dugald C. Jackson, of the Massachusetts Institute of Technology, followed him with a brief talk, in part emphasizing the need of cooperation between engineering colleges and manufacturers. Prof. C. S. Clark, of the Lowell Institute, Boston—a night institution for giving technical training to men occupied by day—outlined their methods and spoke of the success thereof. Director Hamerschlag, of the Carnegie Institute, Pittsburg, protested against the low wages paid by industrial concerns to graduates of engineering schools entering these courses—10 cts. per hr. being, he said, so small as to fail to maintain loyalty, and too little for young men to live on; he further maintained that the courses tend to paternalism, and develop unreliant "infants," in contrast to the men who have to fight their own way up the line. Messrs. C. W. Cross, Superintendent of Apprentices, New York Central Lines; Calvin W. Rice, Secretary of the Society, and Frederick W. Taylor, Past-President, also contributed pointedly to the discussion. Mr. Taylor's argument was: train the college man how to get into and stick to the plain, every-day, monotonous work, to which the acquisition of varied information and experience must be secondary; teach him the somewhat rare art of doing disagreeable things.

AMERICAN ELECTROCHEMICAL SOCIETY.—The 12th general meeting will be held at New York City on Oct. 17, 18 and 19. The first session will be at 8 p. m., Oct. 17, at the Chemists' Club, 108 West 55th St. After a reception Dr. Geo. F. Kunz will give an illustrated lecture on "Diamond and Moissanite—Natural, Artificial and Meteoric"; and Mr. Edw. G. Acheson, of Niagara Falls, will give a lecture on "Deflocculated Graphite," with demonstrations and experiments. (An article by Mr. Acheson on this subject appeared in Engineering News for Aug. 1.)

A session will be held at 9 a. m., Oct. 18, at the same place. Messrs. Albert E. Greene and Frank S. MacGregor will present a paper on "The Electrothermic Reduction of Iron Ores"; other papers for the session are "The Electric Furnace Experiments for the Reduction of Pig Iron at Sault Ste. Marie," Dr. Jos. N. Richards; "Electric Furnace Experiments," Dr. H. N. Potter; "Moissan's Experiments on the Boiling Point of Metals," Dr. O. P. Watts; "The Electrometallurgy of Zinc," Gustav Gin; "A New Application of Chlorine in Metallurgy," C. E. Baker; "Heat Conductivity of Carbon," F. A. J. Fitzgerald; and "Granular Carbon Resistors," Prof. A. S. Tucker. On Oct. 19 at 9 a. m. a session will be held in Havemeyer Hall, Columbia University. Papers for this session are: "Physico-Chemical Notes on the Aluminates of Soda," P. B. Sadtler; "Action of Aluminum Persulphates on Metals," J. W. Turrentine; "Use of the Capillary Electrometer for Alternating Voltages," M. G. Floyd; "Electroscopic Determination of Radium in Some Tufa at Hot Springs, Ark.," Dr. Herman Schlundt; "Electrolytic Separation of Silver and Copper," H. W. Gillette; "Electrolytic Determination of Minute Quantities of Copper," E. E. Free; "Electrolytic Reduction of Nitric Acid," Drs. H. E. Patten and Robinson; "Electrochemical Methods for the Qualitative and Quantitative Determination of Free Silicon in the Presence of Silica, Silicates, Oxides, Free Carbon and Carborundum," W. R. Mott; "Nature of Electrolytic Conductors," Dr. L. Kahlenberg; "Electrolytic Theory of the Corrosion of Iron," Dr. A. S. Cushman (with demonstrations); "Treatment of Storage-Battery Elements Before Putting Them Out of Commission," Prof. O. W. Brown; and "A Further Study of Concentration Cells," Dr. H. S. Carhart.

On Friday afternoon, Sept. 18, an excursion will be made to the laboratories of Mr. Thomas A. Edison, where Mr. Edison will receive the visitors in person; the party leaves the foot of West 23d St. at 2:15. On Saturday afternoon excursions will be made to the Long Island City power plant of the Pennsylvania R. R., the Electrical Testing Laboratories, and the large electrolytic copper refinery at Chrome, N. J. Saturday evening there will be a smoker at the Chemists' Club. Hotel headquarters will be at the Cumberland, 54th St. and Broadway; registry headquarters will be at the Chemists' Club.

NEW JERSEY SANITARY ASSOCIATION.—The 33d annual meeting of this association was held at Atlantic City, Oct. 1 and 2, in connection with the American Public Health Association. In the course of his presidential address Dr. G. K. Dickinson spoke of the need of specific training for sanitary officers, suggested that there should be at least "one accepted sanitarian" on every board of education, and expressed the opinion that in place of the ordinary city board of health, composed of numerous members, there might better be a single executive health officer, who might, if he chose, associate two other men with him in the care of the public health.

All the papers and discussions at this meeting related to various phases of the milk supply of cities. Dr. Thomas Darlington, Health Officer of New York, stated that the milk supply of New York City is drawn from 30,000 dairies scattered throughout six States, at distances ranging from 25 to 400 miles from the city. The work of milk inspection should, he believed, be properly subject to State or Federal control, pending which it would be necessary for cities to look after the purity of their milk supplies. A yearly appropriation of $450,000 would be required to properly inspect the dairies producing the milk brought to New York City.

In an address on milk by Prof. R. A. Pearson, of Ithaca, N. Y., some interesting counts of the numbers of bacteria carried by flies under various conditions were cited. These studies, which were made in Connecticut, consisted first in catching "your fly"; second, giving it a thorough rinsing in water; and third, proceeding to make a bacterial count. By these means it was found that an ordinary fly carries around with it some 300,000 bacteria, a stable-fly over 800,000, and a [illegible] fly 1,000,000. The wife of this investigator having asserted that house-flies were much cleaner than those just mentioned, the investigator swooped down on the garbage can, and, after going through the necessary processes, found that a fly caught there was laden with no less than 1,500,000 bacteria.

Valuable figures on the cost of producing milk under various conditions were given by Prof. E. B. Voorhees, of New Brunswick, N. J. The capital expenditure for 100 acres of land, necessary buildings, and dairy equipment and cows to produce a given quantity of milk was estimated to be $25,600 for a "perfect" dairy, $16,100 for a "practical" dairy, and $8,850 for a "careless" dairy. The corresponding yearly operating expenses, interest and depreciation were placed at $8,940, $6,[illegible] and $3,003 per year, and the cost per quart of milk produced at 6.55, 4.83 and 4.70 cts. For the perfect and the practical dairies, a herd of 40 cows was assumed, costing $75 each, and for the careless dairy a considerable number in addition. A number of other phases of the public milk question were presented by other speakers.

The association elected Mr. John B. Duncklee, M. Am. Soc. C. E., of South Orange, as President for the ensuing year, and re-elected Dr. James A. Exton, of Arlington, N. J., as Secretary and Mr. George P. Olcott, C. E., of East Orange, as Treasurer. Prof. John B. Smith, of New Brunswick, was chosen as Chairman of the Executive Council. It was decided to hold the next meeting at Lakewood, probably in December, 1908. The report of the treasurer showed a balance of $210.

AMERICAN PUBLIC HEALTH ASSOCIATION.—The 35th annual meeting of this association was held at Atlantic City, Sept. 30 to Oct. 4. At the Laboratory Section, on the first day of the convention, many papers were presented on water, milk and food analysis and various related subjects. The program of this section included a paper by John A. Amyot, of Toronto, on "Effect of Wind-Currents on Pollution in a Great Lake"; one by Edward Bartow, of Urbana, Ill., on "Normal Waters of Illinois"; one by Prof. Earle B. Phelps, of Boston, Mass., on "Experiments on Disinfection of Sewage and Sewer Filter Effluents"; besides papers on many other subjects of less interest to engineers.

During the convention a section on vital statistics was organized, and consideration was given to the advisability of organizing a section for health officers. The program for the general meetings of the association included, among other things, papers and discussions on vital and typhoid statistics, milk supply, the campaign against tuberculosis, and the relation of streets and roads to public health. On the last-named subject, Mr. A. L. Cushman, of the office of Public Roads, U. S. Department of Agriculture, was scheduled for a paper.

Mr. Robert Spurr Weston, M. Am. Soc. C. E., of Boston, Mass., read in abstract a lengthy paper prepared by himself and Mr. Ralph C. Tarbett, on "Typhoid Fever at Knoxville, Tenn., and Its Relation to the Water Supply." The typhoid rate at Knoxville is now about 56 per 100,000, as compared with an average of 19 for the State of Massachusetts. The speaker stated that it was unfair, however, to compare typhoid rates of Southern with those of Northern cities, inasmuch as, owing to special conditions in the South, the typhoid rate there is generally much higher than in the North. Even cities in the South with pure artesian or filtered water have high typhoid rates.

The water supply of Knoxville is taken from the Tennessee River by the Knoxville Water Co. The population on the drainage area above the intake is sparse. The intake is above all the city sewer outlets. Warren mechanical filters, combined with a coagulating basin, were built in 1904. The sand in these filters is coarse, and most of the work done is effected in the coagulating basin. The filter plant during the past three years has been in charge of a bacteriologist. Presumptive tests for B. coli have shown 33% of the samples of raw water positive, as compared with 10% of filtered water.

Recent marked rises in the typhoid rate in Knoxville have apparently been connected with an influx of negroes from the country districts in 1903. The negro population of the city, as a whole, suffers much more than does the white from typhoid. A canvass of typhoid deaths has shown that only 44% were patients who used city water, while the deaths among negroes showed that only 21% took the filtered water supplied by the company. Many polluted limestone springs are used instead of the public supply. The author suggested that in the future much could be learned if the typhoid cases in Knoxville were studied in detail as they occur. In connection with the discussion on this paper, several speakers bore witness to an increase in typhoid fever coincident with the closing of streams by ice, such streams being drawn upon for public supplies. One speaker stated that until within the past five weeks there had been very little typhoid in his city, and also very few flies, but since the advent of flies the typhoid had been increasing.

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